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RADIO & ELECTRONIC COMPONENTS

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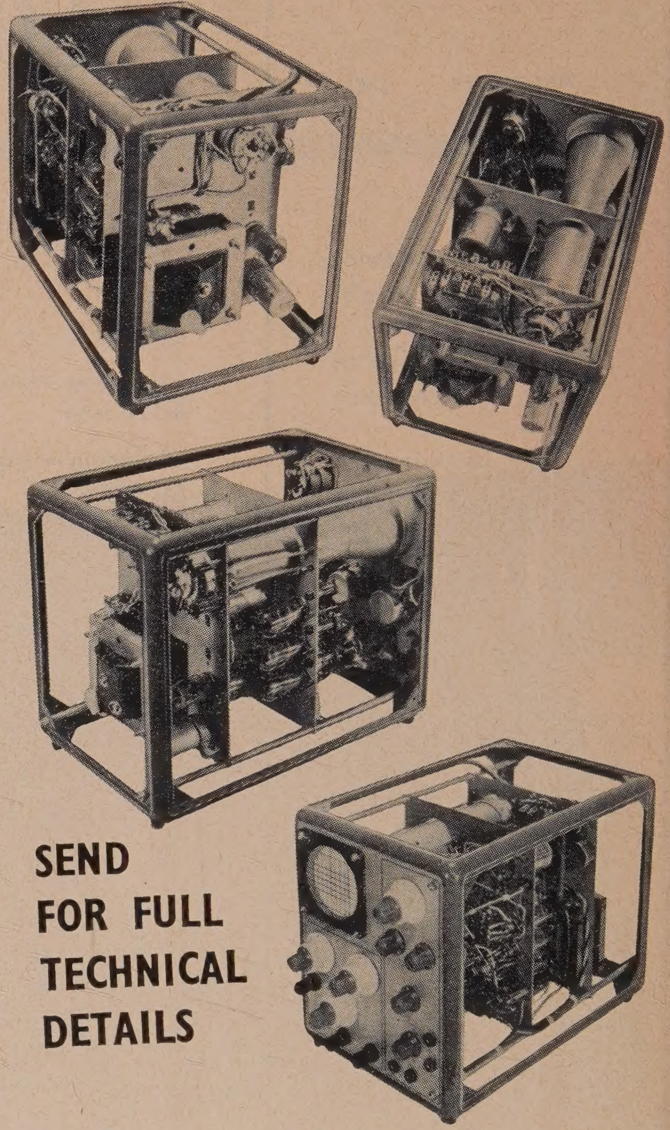

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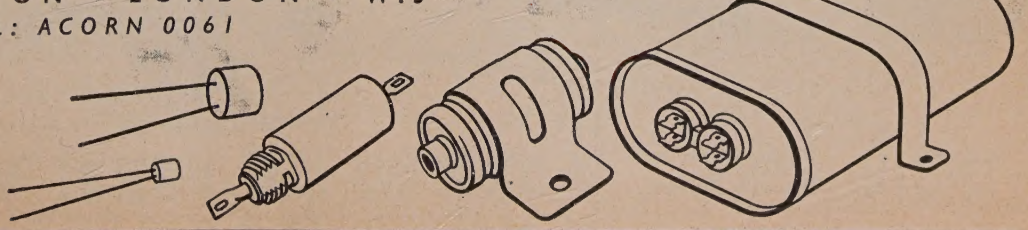

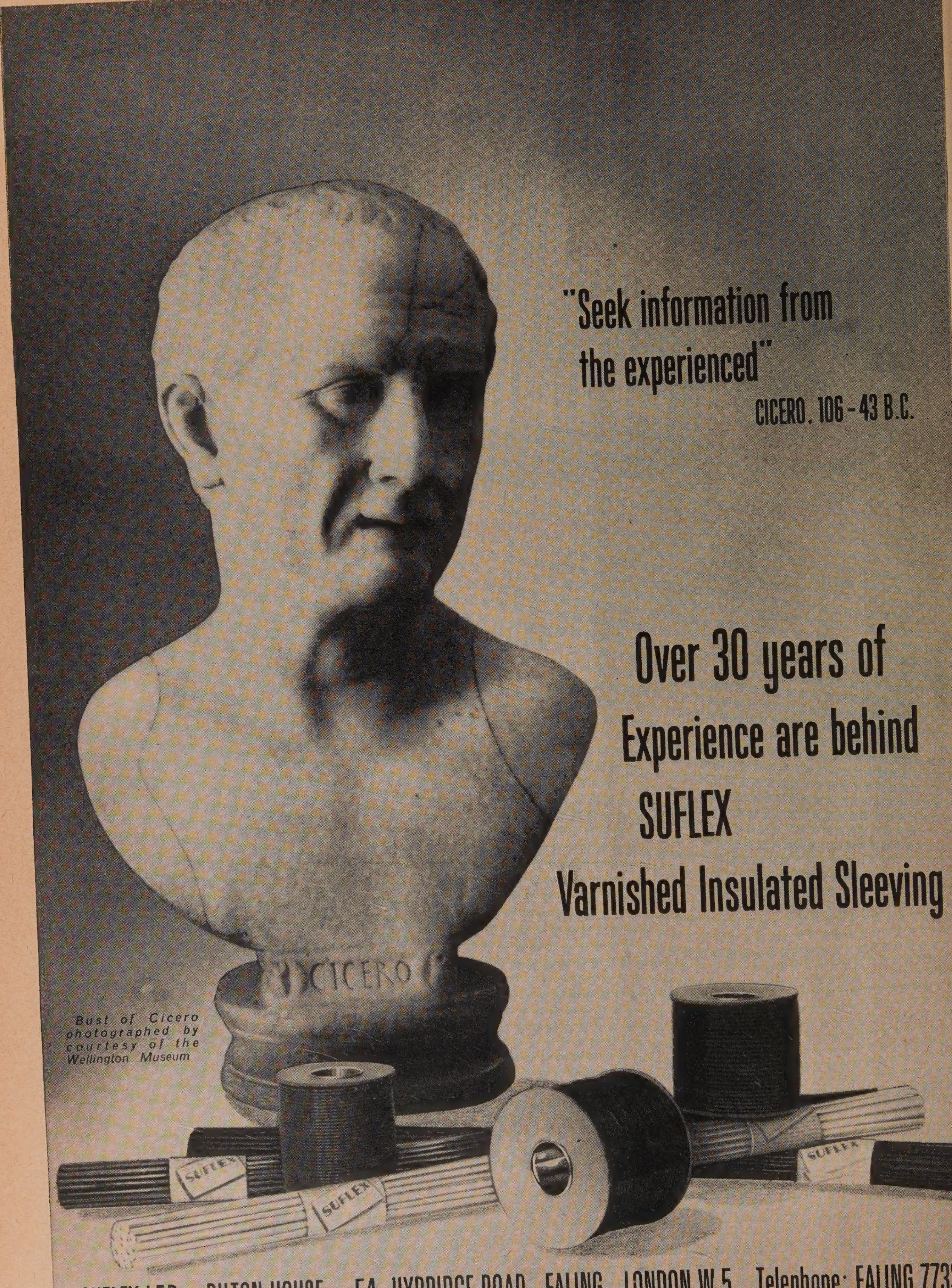

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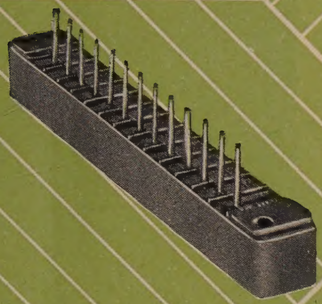

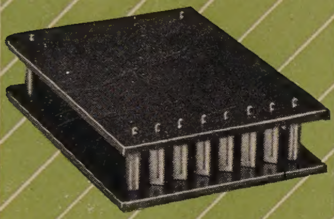

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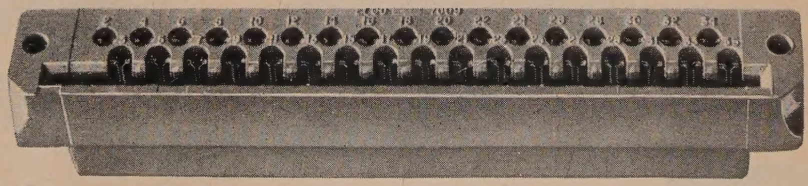

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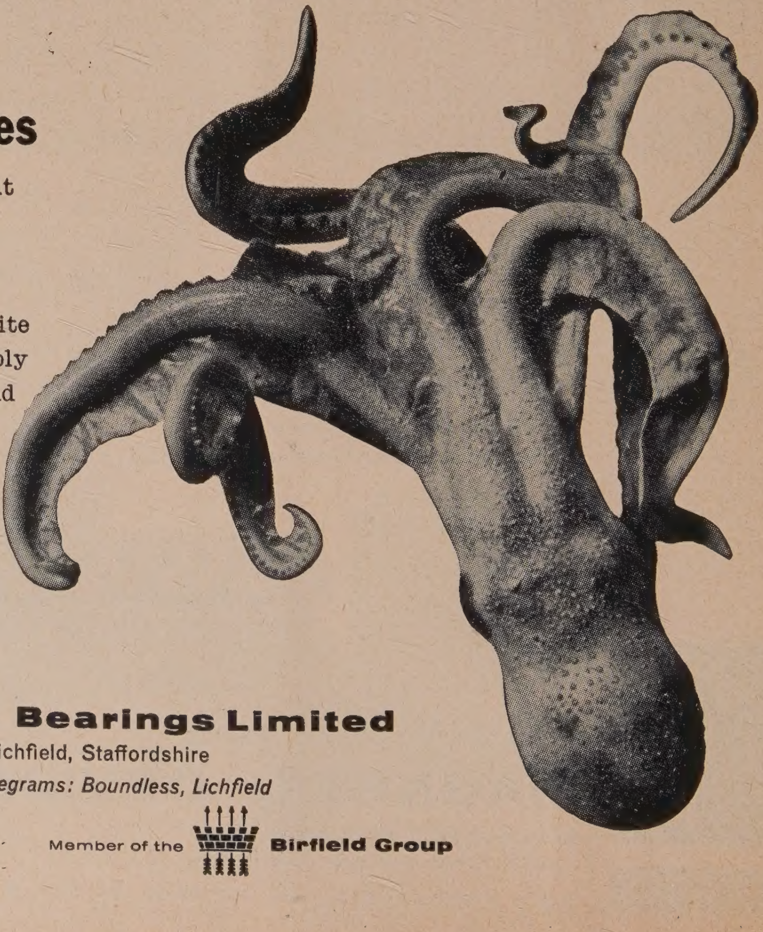

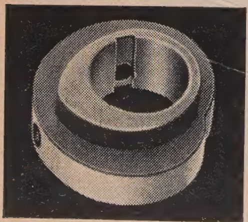

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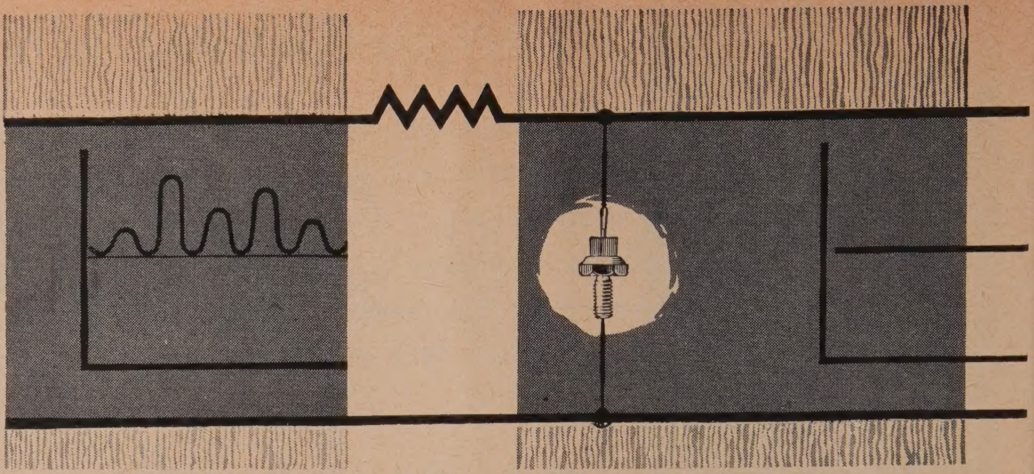

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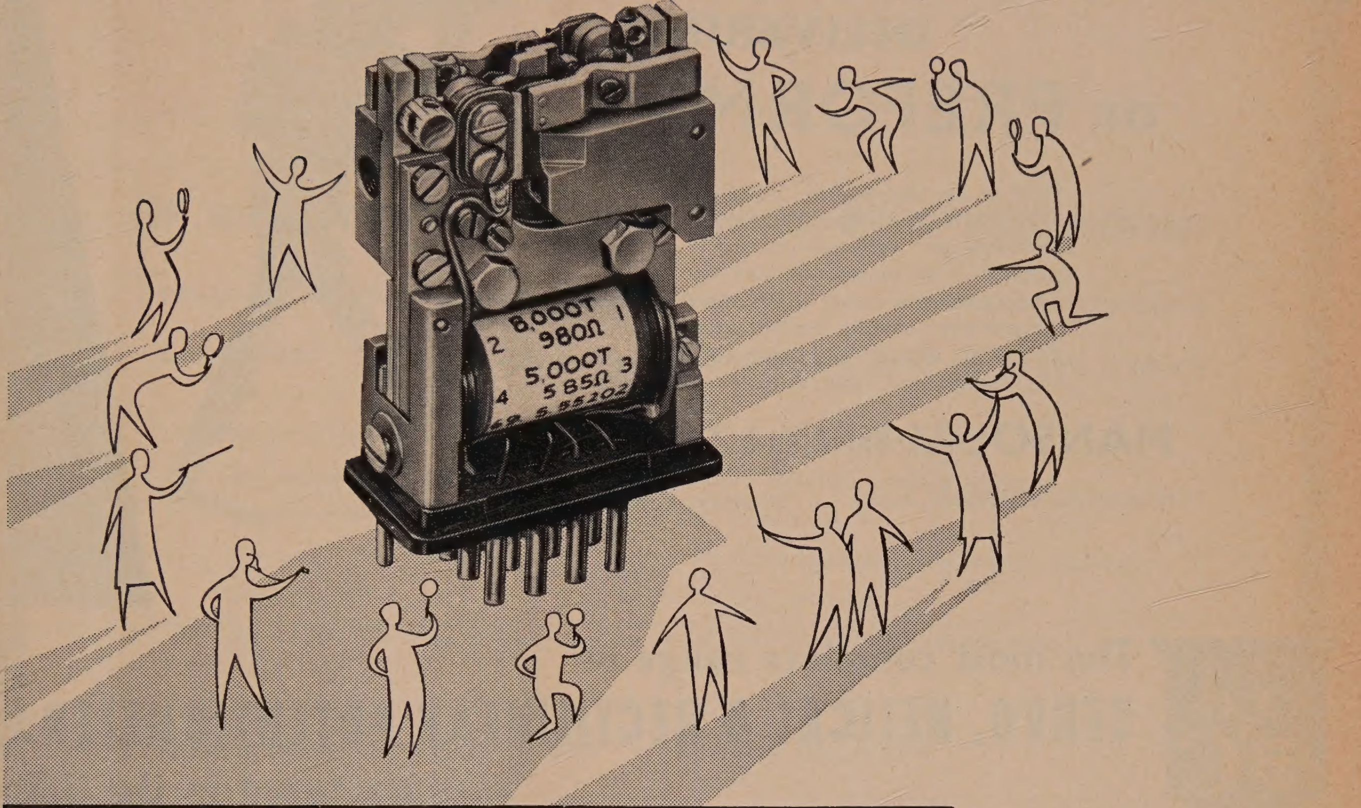

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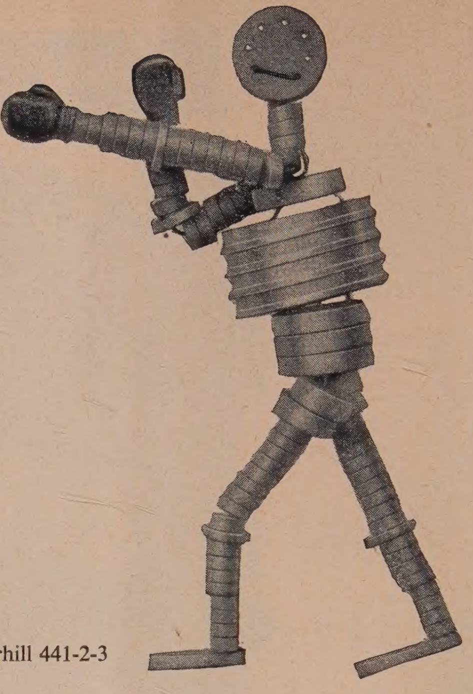

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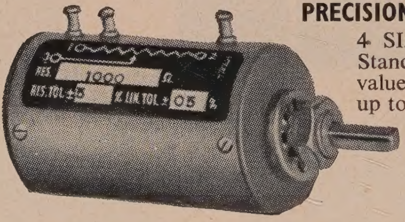

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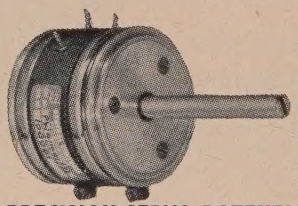

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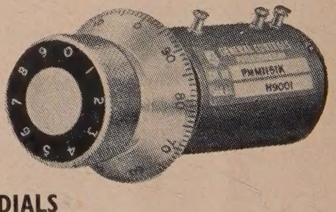

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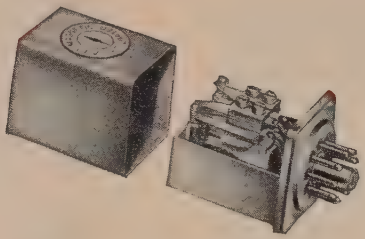

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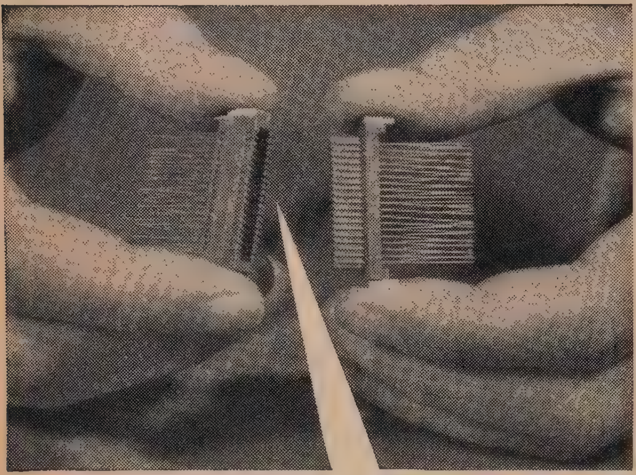

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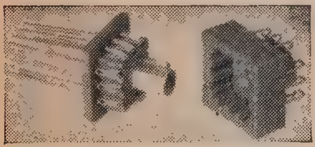

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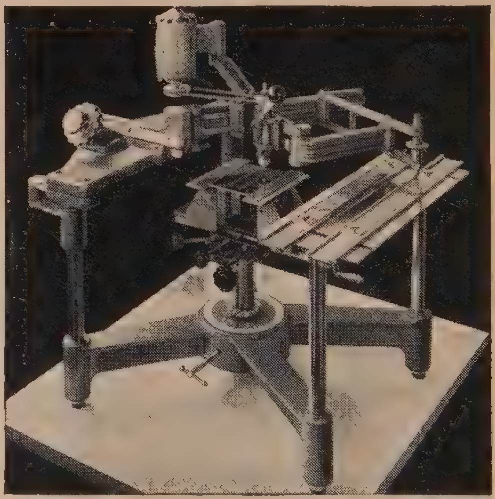

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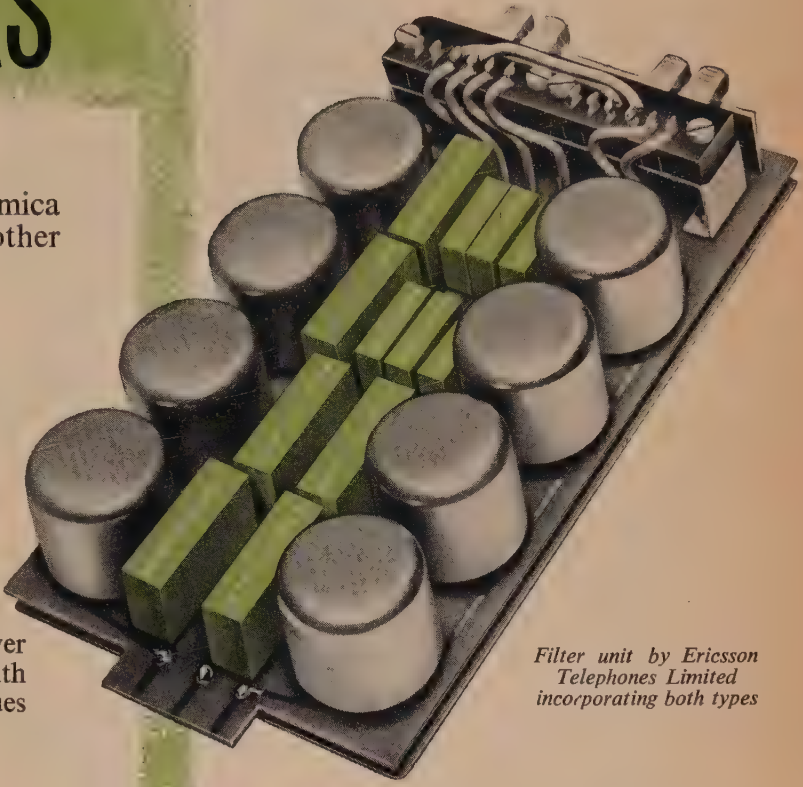

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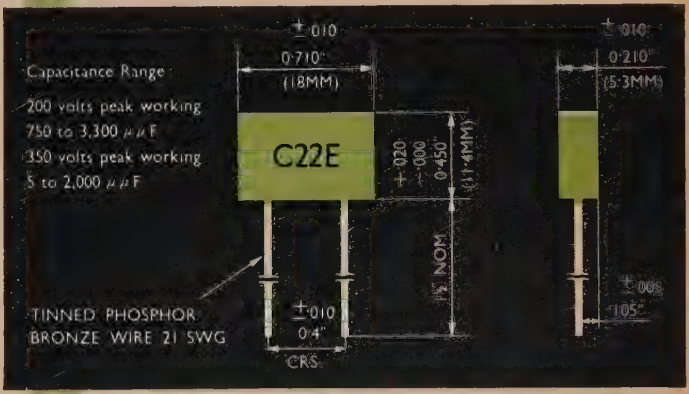

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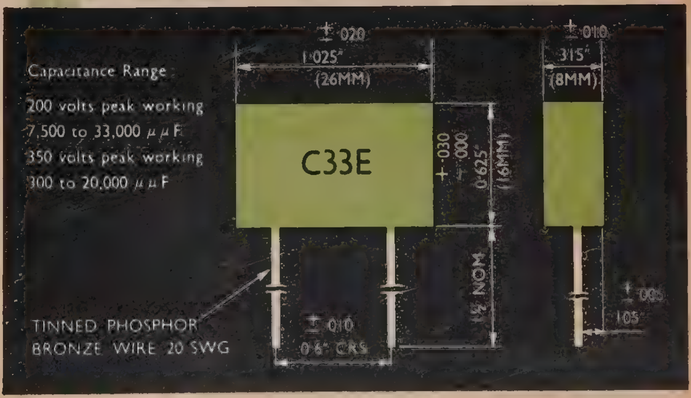

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RADIO & ELECTRONIC COMPONENTS

Commentary

Planning for Market Day

FROM an editorial desk, it is interesting to sit back and view the activities which are now proceeding as a prelude to the almost certain entry of Great Britain into the European Common Market. The very fact of joining means the breaking of traditions which have been firmly established in this country for many years past. It is, indeed, particularly significant when a trade association—having been in existence for close on fifty years—decides to change its name to one more in keeping with modern times and developments.

The 'National Union of Manufacturers' now becomes the 'National Association of British Manufacturers'. The inferences are fairly obvious—it is now necessary to ensure that people outside Great Britain recognize a particular association as that which is serving British manufacturers and also that the word "Union" is not misconstrued. One can feel sure that an organization representing over five thousand individual manufacturing firms throughout Great Britain and Northern Ireland does not take such a step lightly—it will probably mean some confusion in the first place but the Association is obviously determined to plan on a long-term basis and to serve its members in the best possible way.

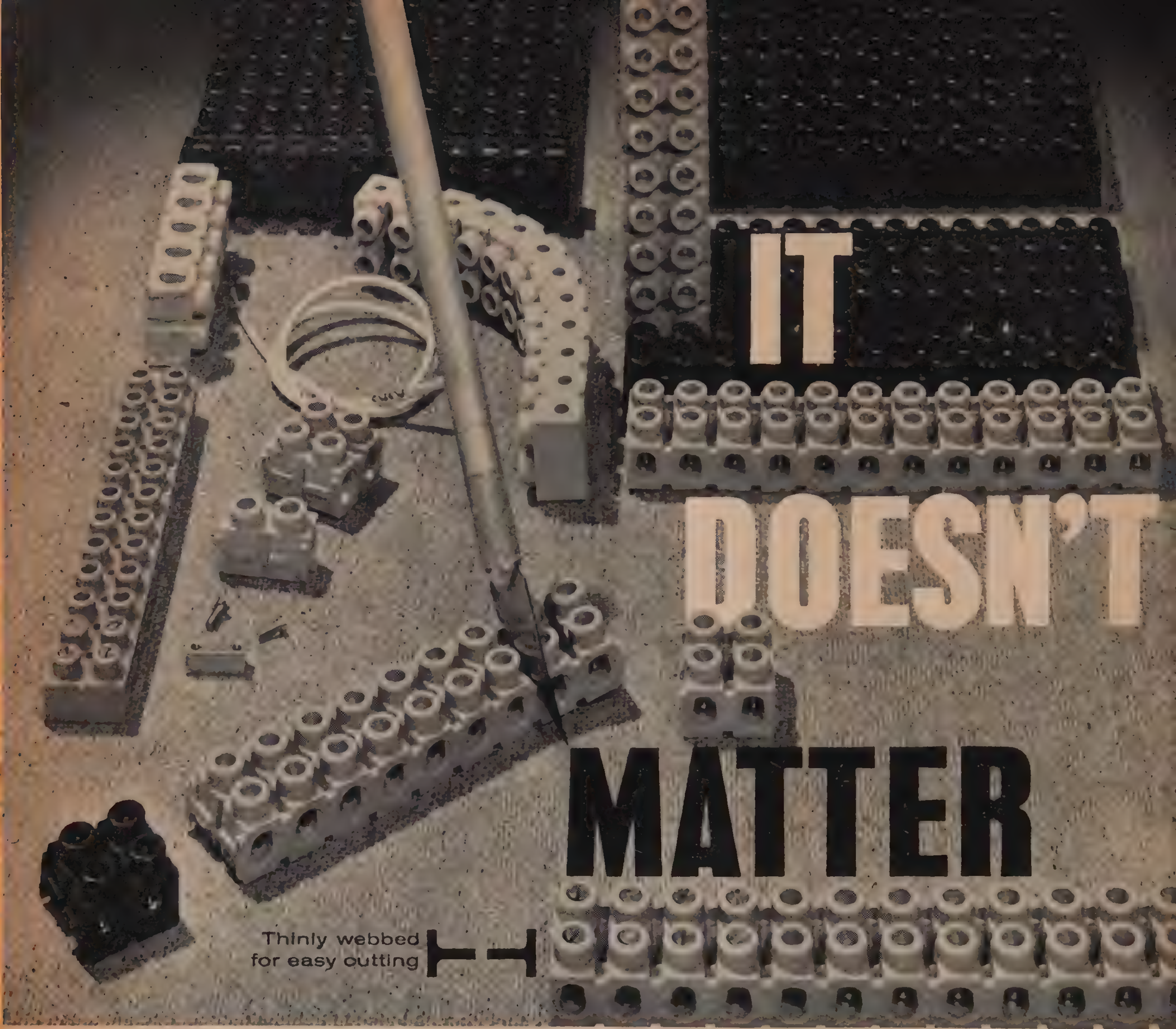
If our entry into the Common Market is only a few months away—which in terms of production and planning means "tomorrow"—then now is the time to study the requirements of the new markets and to ensure that our goods are to the right specifications and will sell at the right price. Early difficulties are bound to be caused by differences in the monetary and measuring systems employed by ourselves and the various European countries in the Scheme but these must be overcome, even if it involves Great Britain in switching over to the decimal system of coinage and the metric system of measurement.

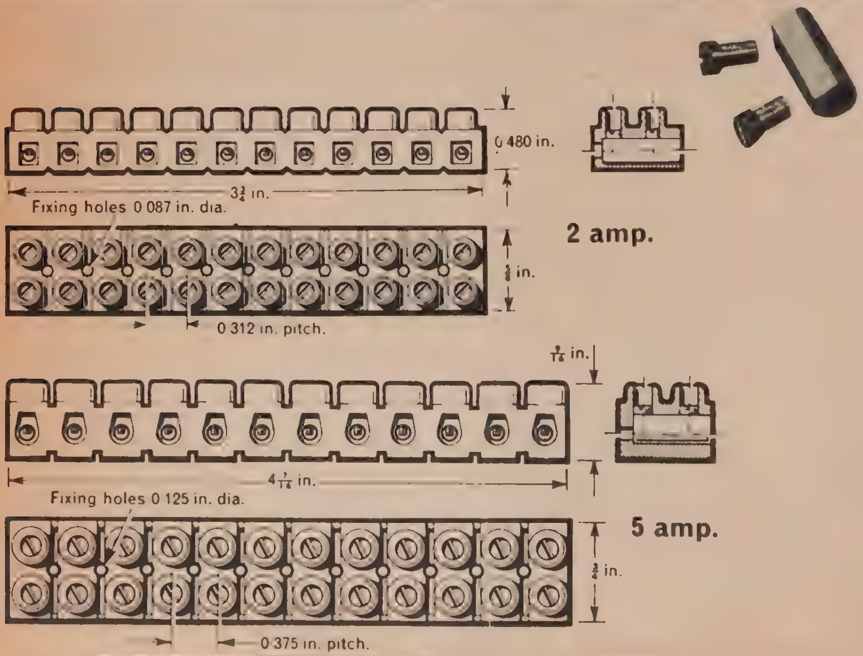
The electronics industry has grown to its present importance by an initial impetus given during World War II and has existed mainly through the false economy of cold war and political tension. Government defence contracts have bolstered the development of the huge electronic groups which have in turn kept countless small firms working to capacity by sub-contracting. This cannot go on for ever and eventually the balance will swing to a complete buyers market. This has already begun with the winding-up of Government missile and other advanced development projects and the wider horizons of the European Common Market would, therefore, seem fortuitous. Selling in the face of keen competition, as against the sinecure of sponsored work with seemingly scant control of money spent, will mean radical rethinking on the part of many firms and a more fluid work force will have to come into being.

Inducements must be high enough to keep the British scientists in British industry to prevent the drift to high-paying American companies with factories on the continent. We cannot afford to lose first-class brains especially when we may be on the brink of one of the greatest trading ventures this country has ever known.

Another likely possibility is that the growth of market research organizations in this country will become more apparent as the Common Market draws nearer. A large number of our firms—especially the smaller ones—are going to find it extremely difficult to search out their markets abroad and test the strength of their foreign competitors. Market research can provide most of the answers but only at a very high cost. The system has been in use in America for some years but its development in Great Britain has been slow and on a very small scale. The reasons for this are many—and in the electronic components field especially the industry has been doing so well in past years that there has not been any real need for this type of research other than that carried out, somewhat haphazardly, by a sales force of a company.

British industry will have to do some serious rethinking, reorganizing and replanning. News of its various activities will be carried in the editorial columns of this *Journal* and we earnestly advise our readers to make a close study of the changes that must certainly take place in order that they are not left behind in what may well be a race for survival.





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COLD-CATHODE THYRATRONS

For Mean Currents of Several Amperes

by

H. E SEIFERT, Cerberus A.G., Mannedorf, Switzerland

Gas-filled cold-cathode tubes have been used mainly as glow discharge tubes or as arc discharge tubes for short pulses (e.g. electronic flash tubes). The development of a new type of cathode has made it possible to produce arc discharge tubes for continuous currents of several amps. Hitherto this has been only possible with heated thyratrons. This article describes the operation of these new tubes. Three typical circuits are shown and preliminary results on the life expectancy of the tubes are given.

ELECTROMECHANICAL switches can be used only if the definition of the switching operation in time is not critical, and if the number of operations is relatively small. Their advantages are sturdy construction, high permanent currents and the possibility to operate a number of contacts simultaneously.

In many modern applications, switches are required that give very precise switching and which can withstand a large number of operations. Electronic valves (both vacuum and gas-filled) have found increasing usage because of their much faster operation. Also, over the last few years, controlled semiconductor switches have made their appearance.

There is no doubt that the fastest and most precise switch is the vacuum electronic valve. But the high voltage drop across the valves, and the resulting poor efficiency, has tended to limit its use to relatively low powers. On the other hand, the gas or vapour filled thyratrons with their large reserve of current can switch power levels comparable to those handled by electro mechanical switches with reasonable efficiency.

A big disadvantage of thyratrons is the considerable heating power they use. Normal types for industrial purposes (e.g. for the control of motors or lighting equipment) use approximately 10 W of heating power to control 1 A of anode current ⁽¹⁾. The disadvantage of this high stand-by power is especially marked if the tubes are used with a low duty cycle. Mercury-filled thyratrons have the added limitation that their mounting position is restricted. Also, the relatively large volume of these thyratrons often militates against modern equipment designs where the tendency is always towards reduction in size.

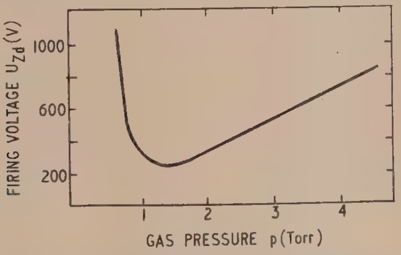


Fig. 1. Curve of the firing voltage U_{Za} of a gas discharge gap *versus* the gas pressure p for electrodes of given form and material and for given distance between the electrodes.

The filling pressure of conventional thyratrons is approximately 10^{-2} Torr. It will be seen from Fig. 1 that this low pressure gives a high breakdown voltage between the electrodes. On the other hand the U_{Zd}/P curve is steep so that the performance of the tube varies rapidly with gas pressure. Changes in gas pressure due to variations of the ambient temperature or due to gas clean-up change the firing-characteristics and limit the usefulness of the tube ⁽²⁾.

The cold cathode thyratrons available hitherto have only been capable of much lower powers than the heated cathode thyratrons. For types using glow discharge the voltage drop in the value is approximately 100 V at a current of 0·1 A maximum. Arc discharge types have a voltage drop of about 15 V and peak currents up to 300 A ⁽³⁾; however the mean current must not exceed 0·1 A.

A new cathode has now been developed that gives an arc discharge with a voltage drop of only 15 V between cathode and anode and allows continuous currents of several amperes with good life expectancy. With this new cathode, a range of thyratron-like tubes have been made that can, in many cases, perform the functions of a heated thyratron in combination with the advantages of a cold-cathode tube.

The working pressure of cold-cathode tubes is much higher than for heated thyratrons. In the firing diagram (Fig. 1) it lies to the right of the minimum. In this flat portion of the curve, variations of the firing voltage caused by variations of pressure (i.e. by variations of ambient temperature, working temperature etc.) have no great effect and the effect of gas clean-up is of minor importance. On the other hand, it is practically impossible to realize working voltages above 1000 V with a reasonable tube construction. In many cases however, switching and control operations use voltages having a peak value below 1000 V.

The construction of these thyratrons is indicated schematically in Fig. 2(*a*). Between the auxiliary anode *HA* and the cathode *K*, a gas discharge is maintained and fills this gap with positive ions and electrons. These ions and electrons are not distributed uniformly in the space —the negative electrons concentrate near the auxiliary anode. Some of these electrons penetrate through the auxiliary anode but their extent is dependent upon the potential of the control grid *G*. If the control grid is given a positive voltage relative to the auxiliary anode, electrons are attracted from around the auxiliary anode, penetrate the grid and are accelerated to the anode. At sufficiently high anode potentials, the electrons will ionize the gap between grid and anode, and the tube is fired. Like all gas discharge gaps, the tube can only be extinguished by interrupting the anode circuit or by lowering the anode voltage below the arc discharge maintaining voltage.

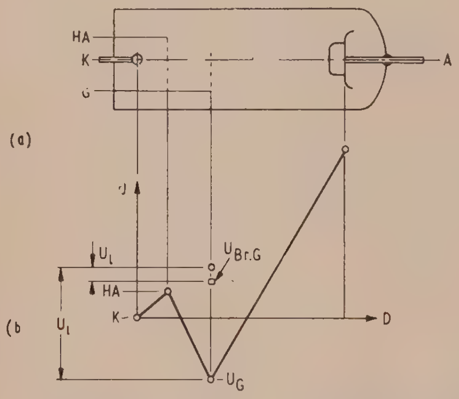


Fig. 2 (*a*). Schematic construction of an arcotron tube (*b*) potential distribution along the tube axis *D*; $U_{Br.G}$ = maintaining voltage of the control grid; U_i=voltage of control pulse; $U_i^* = U_i - (U_G + U_{Br.G})$ pulse over-voltage.

1. Cathode and Auxiliary Discharge

Electrons from cold cathodes in gas discharges (for the currents of interest in this connection) can be produced in two different ways:

(*a*) In a glow discharge, positive ions free the electrons from the cathode (γ-emission) (4·5). The effect depends primarily on the mass and velocity of the ions and on the cathode material. The cathode may be heated by the process but the temperature rise is incidental to the production of the γ-emission.

(*b*) In an arc discharge the electron emission is thermionic, and the cathode is heated by the kinetic energy of the ions bombarding it.

In a gas discharge tube it is possible to have either type of discharge, and for transitions to occur from one to the other. An example of this is for a glow discharge, at a sufficiently high current, to generate enough heat at the cathode to cause a significant amount of thermionic emission and hence an arc discharge. The interelectrode voltage in a glow discharge is about 100 V and in an arc discharge about 15 V. Therefore, in a tube where the discharge is initiated by a certain potential on the control electrode, this possible "step" in interelectrode voltage must be avoided. This is achieved by having an auxiliary anode current high enough to always maintain an arc discharge, i.e. some small part of the cathode must be maintained at a high enough temperature. In order to minimise the energy in this auxiliary discharge, it is arranged, by suitable gas-filling and design of the cathode, that the auxiliary discharge only covers a very small part of the cathode surface. Also, the cathode surface is well insulated thermally. A direct current of 10 mA is sufficient to initiate the arc discharge within a few microseconds (Fig. 3). Thus, to maintain the tube in a state ready for switching, the auxiliary discharge consumes a continuous power of only 20 V at 0·01 A (0·2 W). With this low heating power it has been possible to make tubes capable of continuous currents up to 6 A and peak currents of 250 A.

Approximately 300 V is needed to fire the auxiliary discharge when the tube is cold. The difference between the firing and the maintaining voltage is catered for by a current limiting resistor, and the total energy associated with the auxiliary discharge i.e. in the tube and in the associated resistor, does not exceed 3 W.

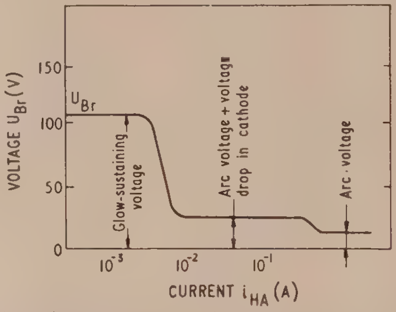


Fig. 3. Voltage/current characteristic of the arcotron cathode.

When feeding the auxiliary discharge from a.c., the discharge is ignited in every positive halfwave and extinguished during the negative half waves. In this mode of operation, the three firing steps, glow and arc discharge can be recognized clearly (Fig. 4). It is important to note that the tube is only ready for switching after the auxiliary discharge is ignited e.g., if the auxiliary anode is fed from 380 V a.c., ignition occurs at a phase angle of 35° maximum. For most practical applications this is no inconvenience. If this delay should be a disadvantage, the auxiliary discharge may be fired earlier with a phase-shifted alternating voltage, and the duration of the glow region between ignition and arc discharge, shown in Fig. 4, can be shortened by increasing the discharge current at the moment of ignition. To maintain the auxiliary arc discharge, a certain minimum heating power in the cathode is necessary. Thus, when the auxiliary discharge is run with half waves it needs a somewhat higher mean current than for a d.c. supply. For a 380 V a.c.-tube with the auxiliary discharge fed from the main anode a current limiting resistor of 7·5 kΩ is sufficient to avoid the glow region entirely (Fig. 4).

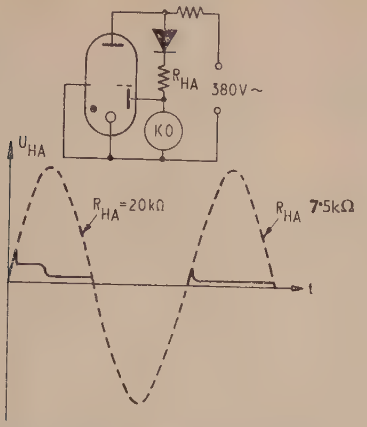


Fig. 4. Voltage/time characteristic of the auxiliary anode *HA* when fed from a.c. with different current limiting resistors R_{HA}.

The maintaining voltage of the arc is generally equal to the ionization voltage of the filling gas. For the Arcotrons this is approximately 12 V, and when the cathode is cold it has an internal resistance equivalent to 15 V—hence, a voltage of 27 V would be measured externally. With continuous currents of the order of one ampere the deeper regions of the cathode get sufficiently warm to reduce the internal resistance to a negligible value. This is accompanied by a reduction of the external voltage drop between the electrodes to the expected 12 V.

2. Control Grid

When the bulk of the cathode is cool, the grid, connected to the cathode terminal, is approximately 15 V negative with respect to the cathode surface due to its internal voltage drop. The decelerating field between the auxiliary anode and the grid is, therefore, twice as strong as the accelerating field between the cathode and the auxiliary anode. The first electrons can thus reach the grid only if this is approximately 15 V positive with respect to the cathode terminal.

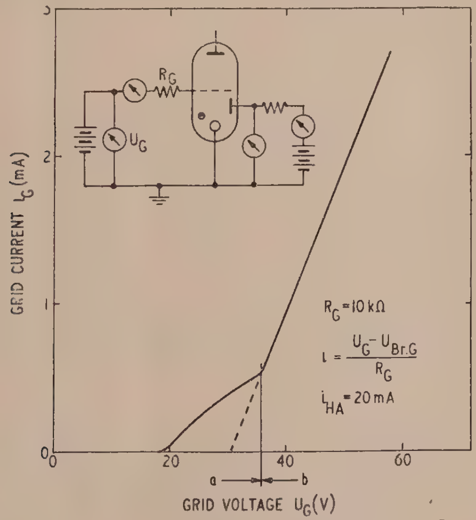


Fig. 5. Grid current i_G as function of the grid voltage U_G for a "cold" cathode.

Fig. 5 shows the curve of grid current *versus* grid/cathode voltage. In region *a*, the grid acts only as a probe in the discharge between the auxiliary anode and the cathode. With high negative voltages, only a few electrons reach the probe (corresponding to a current of maximum 1 μA) and these are not able to ignite the tube even when the maximum anode voltage is applied. If the grid has a voltage that only differs by a few volts from the voltage of the auxiliary anode, fast electrons may penetrate towards the grid (or the latter may even attract them) and, a grid current of the order of 100 μA, will flow. In the region *b* the grid is more positive than the auxiliary anode and takes over the function of an anode. Here the current/voltage characteristic is only determined by the current limiting grid resistor R_G and by the difference between supply voltage U_G and the maintaining voltage between grid-cathode, $U_{Br.G.}$. (Due to the larger grid-cathode spacing, this maintaining voltage is some volts higher than the maintaining voltage of the auxiliary anode.)

It has been explained that the apparent maintaining voltage of the cathode may change by approximately 15 V depending on the tube current. Naturally, this change also influences the grid current so that the characteristic shown in Fig. 5 may be displaced by 15 V to the left. It is preferable to maintain the grid current, independent of these variations, and this is done by using a high grid supply voltage U_G.

In a gas-filled tube, any electrode may become a cathode if it is given a sufficient negative voltage with respect to the neighbouring electrodes (6, 7). Because of this, the negative voltage on the grid must not be more than 100 V with respect to the auxiliary anode. (It is sufficient for practical purposes, that $U_G = -20$ V, with respect to the cathode terminal, corresponding to —45 V with respect to the auxiliary anode.) Should a glow discharge occur between the grid and auxiliary anode, i.e. the grid taking the function of a cathode, the gap to the main anode would be ionized and the tube could not be controlled.

3. Anode Gap

To allow the tube to pass current from the cathode to the anode, the anode gap must be ionized. To carry the current in the gap, a minimum charge density is required. The number of charge carriers, electrons and ions, furnished by the auxiliary discharge under normal conditions is not sufficient, and supplementary charge carriers must be created in the anode gap. The electrons that enter this gap through the grid start an avalanche of charge carriers under the influence of the anode voltage. This formation of charge carriers is a function of the ionizing voltage of the filling gas and of the anode voltage. Thus, the higher the anode voltage, then the lower is the required number of "primary" electrons.

Normally the tube is controlled by pulses on the grid. The necessary control power depends on the anode voltage—Fig. 6 gives some quantitive values. The x-axis is the effective pulse "over voltage" U_I* as defined in Fig. 2 (b); the y axis is the minimum duration of the pulse before the anode current flows, and curves are given for four anode voltages. If the grid resistance R_G is reduced from the indicated 100 kΩ to 10 kΩ the necessary pulse duration is only reduced by a factor of approximately 2. Only with very small grid resistance (e.g. 1 kΩ) does the change become important, as can be seen from the dotted curve $U_A = 400$ V and $R_G = 1$ kΩ.

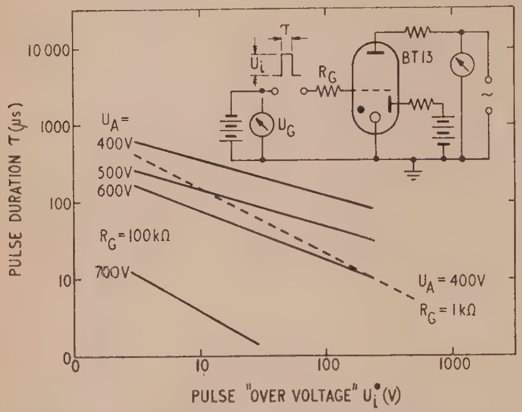


Fig. 6. Pulse duration τ necessary for firing the anode gap as a function of the pulse "over voltage" U_i* for various values of anode voltage U_A and grid resistor R_G.

4. Control Characteristic

The control characteristic of the arcotron tube is shown in Fig. 7. It indicates the minimum anode voltage necessary for firing the tube at various grid voltages, and gives interesting information on the control mechanism of an arcotron tube. There is a marked "hysteresis" effect due to the variation of internal cathode resistance described before, i.e. the voltages on the inner electrodes are only equal to the voltages at the electrode terminals when the cathode is hot ($I_A \geq 1$ A). As might be expected, the difference between the "cold" and the "warm" control characteristic is approximately 15 V.

The slope of the characteristic in the range of high anode voltages is almost vertical. As this slope is in a range of grid voltages, where there is practically no grid current (Fig. 5) the effect of the grid is that of an electrostatic diaphragm and the electrons leave the auxiliary anode gap under the effect of the electrical field of the main anode.

For anode voltages of 600 V and below, the effect of the anode voltage through the control grid is not so strong. Therefore, the electrons must first be accelerated to the grid before they reach the anode field. For firing the tube at low voltages, the electrostatic action of the grid is not sufficient and the electrons have to be accelerated by the grid and grid current is drawn. This explains the discontinuity of the minimum firing pulse for anode voltages between 600 and 700 V, as indicated in Fig. 6.

5. Deionization

Considerations up to now have been concerned with the ionization of the gas. For fast switching, the deionization time is equally important. Ideally the ionized gas would recombine instantly when the anode voltage is removed but, in fact, the recombination is relatively slow and takes place mostly at the electrodes and the walls. Therefore, the physical dimensions of the discharge gap and the mobility of the ions without an accelerating field largely determine the deionization time.

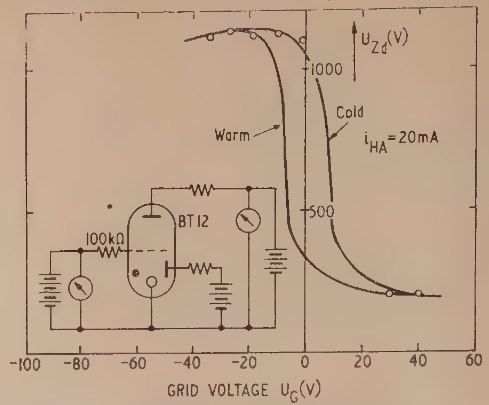


Fig. 7. Control characteristic (anode firing voltage *versus* grid-cathode voltage for constant auxiliary anode current i_{HA}).

The deionization time of the tube is the time interval in which the number of charge carriers has become so small that it is not sufficient to fire the gap when the anode voltage is re-applied. For d.c. fed tubes, this is the shortest interval between extinction of the discharge and the ability to control the tube again (6, 7). For a.c. fed tubes the same measurement is made for ohmic load and has to be supplemented by measuring the commutation factor for inductive loads.

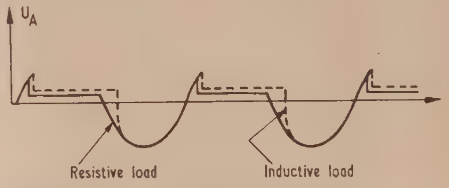


Fig. 8. Voltage *versus* time for a fired a.c. fed BT-tube for ohmic and inductive loads.

In Fig. 8 the sinusoidal voltage at the switching tube for ohmic load and the distorted curve for inductive load are shown. The distortion of the voltage is due to the load and can be calculated or measured. The maximum commutation factor permissible for a tube enables one to calculate if the tube can be used for a given inductive load.

At the beginning of this article, it was pointed out that the arcotron tubes are filled at a higher pressure than heated thyratrons. This results in a slower diffusion of the ions to the electrodes and walls when the tube is deionizing and this causes a reduction of the permissible

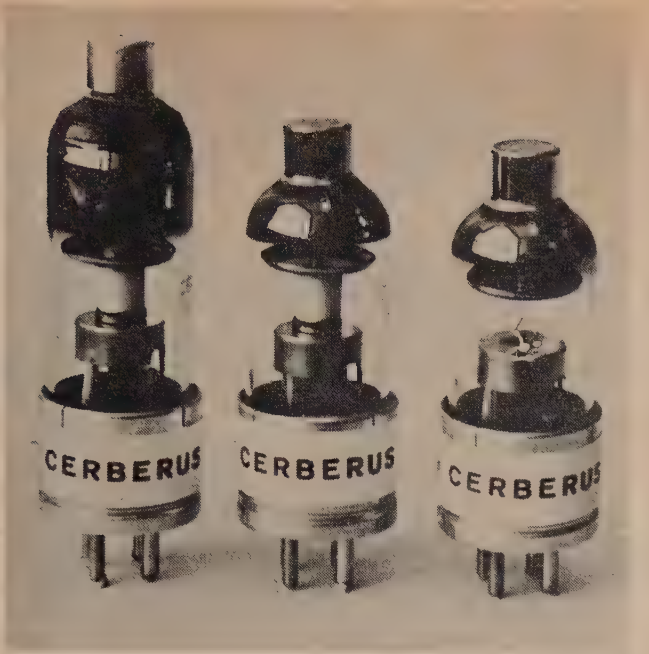


Fig. 9. Three typical arcotron tubes BT 14, BT 13, BT 12 (from left to right).

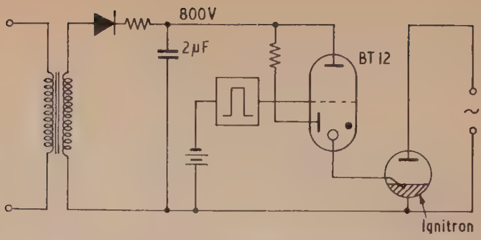


Fig. 10. Principle of the d.c. capacity control of an ignitron.

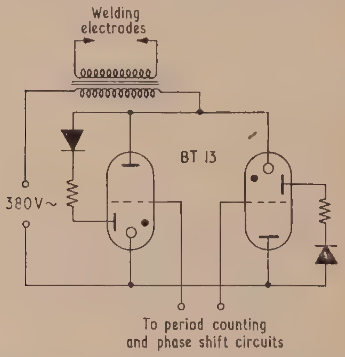


Fig. 11. Simplified diagram of a circuit controlling the primary current of a welding transformer.

commutation factor. In particular, this limits the potential application of arcotrons for motor control to motors where the ratio of the resistance (in ohms) to the inductance (in Henries) is 25 : 1 or more i.e. to motors up to approximately 0·1 PS—.

6. Practical Application of Arcotrons

Fig. 9. shows some typical arcotron tubes:

BT 12: 1000 V d.c., mean current 3 A, peak current 100 A.
BT 13: 380 V a.c., mean current 3 A, peak current 200 A.
BT 14: 380 V a.c., mean current 6 A, peak current 250 A.

These tubes are relatively small; the three types having a bulb diameter of 35 mm; the overall length of the BR 14 (the longest) is 120 mm. Preliminary information on the capabilities of these new tubes, has been obtained in three ways:

1. A number of BT 12 tubes have been used for controlling ignitrons as indicated in a simplified diagram (Fig. 10). Approximately $3{\cdot}5 \times 10^8$ switching operations have been performed up to now.
2. BT 13 tubes have been used for switching the primary current of small spot welders (Fig. 11) and have reached 3,500 working hours [11].
3. The same cathodes as are used in these three BT types have been incorporated in half-wave rectifiers with a mean current of 1·5 A and have been in operation for more than 10,000 hrs.

Up to the present, tests show no significant changes in tube characteristics.

References

(1) Rohde, W.: **Das Thyratron.** *AEG-Mitt.* **41** (1951) pp. 177—182
(2) Hübner, R.: **Das charakteristische Verhalten von Glühkatoden-Gleichrichterröhren verschiedener Gasfüllung.** *Elektron. Rdsch.* **9** (1955) p. 434
(3) Gemershausen, K. J., u. Edgerton, E. H.: **A cold-cathode arc-discharge tube.** *Electr. Engng.* **7** (1936) pp. 790—809
(4) Hagstrum, H. D.: **Auger ejection of electrons from tungsten by noble gas ions.** *Phys. Rev.* **96** (1954) pp. 325—335
(5) Hagstrum, H. D.: **Theory of auger ejection of electrons from metals by ions.** *Phys. Rev.* **96** (1954) pp. 336—365
(6) Tosswill, C. H.: **Relaisröhre mit kalter Katode.** *Philips Techn. Rdsch.* **18** (1956/57) pp. 229—244
(7) Vollenweider, M.: **Kaltkatoden-Relaisröhren.** *Elektronik* **5** (1956) p. 64
(8) Knoop, E.: **Die Entionisierung in Gastrioden und -tetroden.** *Z. angew. Phys.* **9** (1957) pp. 126—132
(9) Hess, K. W.: **Messung der Entionisationszeit von Dioden und Trioden mit Gasfüllung.** *Philips Techn. Rdsch.* **12** (1950) pp. 181—188
(10) Gawehn, H., u. Willibald, G.: **Die Löschzeiten von gasgefüllten Schaltröhren.** *Nachrichtentechn. Fachber.* **9.** (Verlag Friedr. Vieweg & Sohn, 1957)
(11) **Vollelektronische Schweissmaschinensteuerung mit Kaltkathodenröhren.** *Cerberus-elektronik* (1960) No. 14.

COMPONENTS

FOR HIGH-FIDELITY EQUIPMENT

PART 3

By

John Borwick, B.Sc.

In reviewing the special requirements of high-fidelity equipment—to reproduce sounds with the utmost realism—we have so far examined gramophone turntables and pick-ups, tape decks and radio tuners. In this concluding instalment we come to the heart of any high fidelity system, the amplifier, and finally that most important link in the chain, the loudspeaker.

THE MAJORITY of high-fidelity amplifiers are built as two separate units. The first is the control unit/pre-amplifier which accepts the various inputs, equalizes where necessary, controls the volume, tone, etc., and supplies a signal in the region of 0·5 V *via* a few feet of screened cable to the second unit—the power amplifier.

The main function of the power amplifier is to develop sufficient power to drive the loudspeaker, and its chassis will also carry the power supply unit providing h.t. and l.t. voltages for the control unit and perhaps a radio tuner. It follows that the power amplifier is bulky, heavy and generates a fair amount of heat. It should, therefore, be situated somewhere near the bottom of the cabinet, and well ventilated. The location of the control unit is dictated by the needs of easy operation, avoidance of mains hum fields and proximity to the gramophone and/or tape pick-up heads so that these connecting leads may be kept as short as possible.

This explains the preference for the two-unit systems, but even the single chassis "integrated" types may be regarded as consisting of two parts.

Overall Amplifier Requirements

Ever since H. J. Leak introduced his famous "Point One" amplifier in 1945 (the name "Point One" celebrated the reduction of distortion to an unprecedented 0·1%) high-fidelity amplifiers have been expected to conform—that is their technical specifications have to attain almost superhuman perfection, regardless of whether the pick-up and loudspeaker can follow suit.

If there is one feature which can be said to have made this advance possible—besides the notable improvements in valves, transformers and other components—it is the wide use of negative feedback.

This circuit device, properly applied, can simultaneously bring about an improvement under each of the criteria headings listed in Part 1 of this article (October issue), *viz.* frequency response, reduction of harmonic and intermodulation distortion, and noise.

Besides this, negative feedback has useful applications in specific parts of the circuit to be discussed later, including tone controls, and loudspeaker damping.

Briefly, negative feedback involves tapping off part of the signal and injecting it at an earlier stage 180° out of phase. There is, of course, a loss in overall sensitivity, and this is used as a measure of the amount of feedback; i.e., the ratio of voltage gain of the amplifier without feedback to the gain with feedback, expressed in decibels (dB). For example, 26 dB of feedback would correspond to a gain ratio of 20:1. It follows that a feedback amplifier must be designed to possess extra gain initially, but the reduction in distortion amply compensates for this.

Noise

A major requirement in high-fidelity amplifiers, and one in which there has been spectacular progress, is low noise. It is usual to lump inherent noise, stray noise and hum components in a single figure. This may then conveniently be measured as the voltage developed at the output when the input is short-circuited to earth. Expressing this as a fraction of the rated voltage across the load resistance gives a figure in dB. For example, a noise voltage of 0·015 V in an amplifier rated at 15 W (i.e. 15 V across 15 Ω) would be quoted as:

$$\text{Hum and noise} = 20 \log_{10} \frac{0{\cdot}015}{15} = -60 \text{ dB}.$$

Hum and noise are, of course, particularly serious in the first stage of any amplifier, since they will then be subjected to the full gain of the system. The position is further vexed by the high gain required to cater for the very low signals produced by high-quality gramophone pick-ups and tape heads.

The Mullard EF86 low-noise pentode is almost universally employed for this first stage (the Type UF86 being suitable for series heater chains in d.c. equipment). Further precautions include the use of high stability, cracked-carbon resistors in the anode, screen and cathode circuits of this first stage especially, and the fitting of a low-loss valve holder, e.g. nylon-loaded phenolic, which should be preferably skirted.

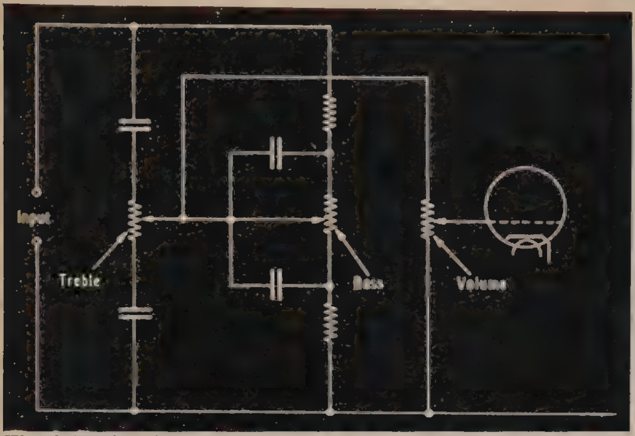


Fig. 1. Typical "passive" tone controls at input of audio amplifier. These give independent boost and cut off about 10 dB for both bass and treble.

Control Unit Facilities

While there are a number of control units on the market incorporating *all* of the facilities detailed below, there is a noticeable trend in new designs towards some degree of simplification. This has no doubt been influenced by the more strict adherence to a standard recording characteristic on the part of the various gramophone companies—eliminating the need for variable equalizer networks, except for owners of substantial collections of older records—and the greater use of the Home, Light and Third radio transmissions from single B.B.C. v.h.f./f.m. transmitting stations—eliminating the need to filter out interfering stations and heterodyne whistles. Also, the necessity of producing easy-to-use ganged controls in stereo amplifiers made fewer controls a virtue.

The full list of facilities is as follows:

Equalization: Until the general acceptance in this country of the disc recording characteristic outlined in British Standard 1928:1955 (substantially the same as the American RIAA curve) some scores of characteristics had been used. Considerable ingenuity was shown on earlier control units to provide precise equalization for these. In, for example, the Quad II control unit (Acoustical Manufacturing Co. Ltd.), push-button selection of r.c. networks allows for no less than 60 record labels. Nowadays, however, switching of three or four networks is considered adequate.

Tone controls: It is normal to include independent control of bass and treble, permitting lift as well as cut. The maximum position of these is stated in dB at given frequencies, typical values being ±10 dB at 50 c/s and 10 kc/s.

Unlike the equalization settings, which may be altered to suit individual discs or tapes, the tone controls are generally adjusted to make up for loudspeaker or room acoustic deficiencies and seldom altered thereafter.

Two basic types of circuit are in common use. The first is a "passive" network of capacitors and resistors which has the effect of tipping the response curve up or down beyond some central frequency, usually 1,000 c/s. Thus, even quite small degrees of control will affect all frequencies above or below 1,000 c/s.

The second arrangement, due to P. J. Baxandall, introduces the filter networks in a negative feedback loop. The lift and cut is first applied at the extreme ends of the scale, and it is only at advanced settings that the middle frequencies are affected.

Filters: Additional steep filters are popular for specific purposes. The high-pass type is referred to as a "rumble" filter, and is designed to attenuate turntable motor noise and sub-audio components which might cause overloading or intermodulation. The slope is 12 dB per

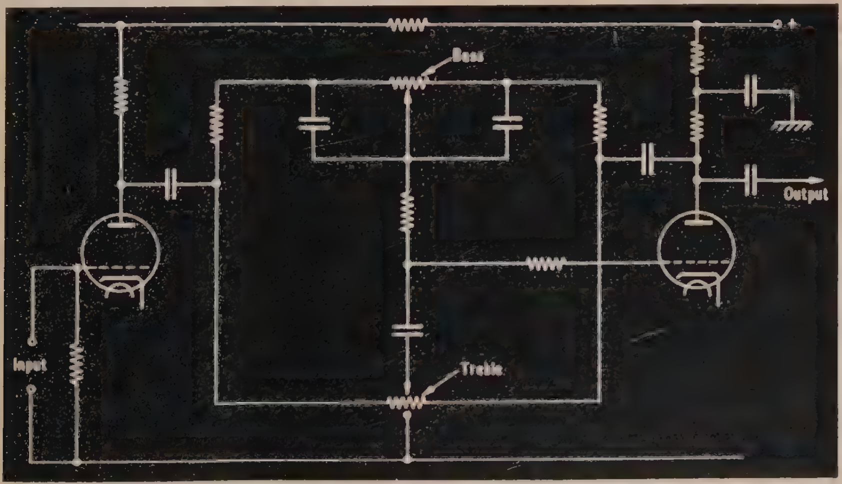


Fig. 2. Tone controls inserted in the feedback loop between two valve stages in the Baxandall arrangement. This has the advantage of giving a roll-off frequency which moves towards 1,000 c/s as the setting is increased.

octave, or more, below some frequency such as 35 c/s.

The low-pass filters are usually switched to "roll-off" from three or four frequencies between 5 and 12 kc/s. They reduce surface noise, distortion, and heterodyne whistles, and sometimes incorporate a "slope" control varying the attenuation rate between say 8 and 35 dB per octave. Tuned inductor or "parallel T" circuits may be used. Hum pick-up has to be guarded against in the former, and low-tolerance resistors and capacitors are essential in the latter.

Volume and loudness controls: The conventional carbon track volume controls are commonly used—the logarithmic law giving smooth control over a wide range. However, the slight unevenness due to the granular nature of the carbon makes the choice of this component a matter of some importance, particularly in the case of stereophonic amplifiers where the ganged potentiometers are expected to keep in step by about ±1 dB. In at least one case, a stud-by-stud control, using fixed resistors, has been employed.

Due to the fact that low-level listening rapidly attenuates the subjective loudness of low and very high frequencies, it is sometimes advocated that a "loudness" control should be used to raise the relative level of these frequencies at low volume settings. This type of control is popular in America, but is not often built into British amplifiers.

Stereo balance and channel reversal: There are two approaches to the question of channel balance in stereophonic amplifiers. Ganged volume and tone controls may be fitted, in which case it becomes necessary to include a balance control. This will increase the gain in one channel while decreasing it in the other. It allows for differences in pick-up or loudspeaker sensitivities in the two channels, etc.

Alternatively, dual-concentric potentiometers may be used, so that individual adjustments will correct for any lack of balance.

There is also provision on many stereo amplifiers for switching the left and right signals to either channel, for combining both channels when monophonic programmes are used, and sometimes for reversing the phase of one channel to check that the acoustical outputs of the loudspeakers are properly in phase.

Power Amplifier Requirements

The sound level from a high-fidelity system should be equal to, or at least approximate to, that of the "live" source in order to provide for realistic reproduction. The amplifier power necessary to produce this depends on room size and loudspeaker efficiency, but 6–8 W for small rooms rising to perhaps 25 W in a very large room is usually considered adequate. In fact, the average power will be around 250 mW, the extra power being required to handle peaks without noticeable distortion.

Single-valve output stages—using a pentode and n.f.b. to reduce the inherent distortion—are normally usable up to power ratings of 5 W only. Accordingly, some form of push-pull circuit is the rule for high fidelity.

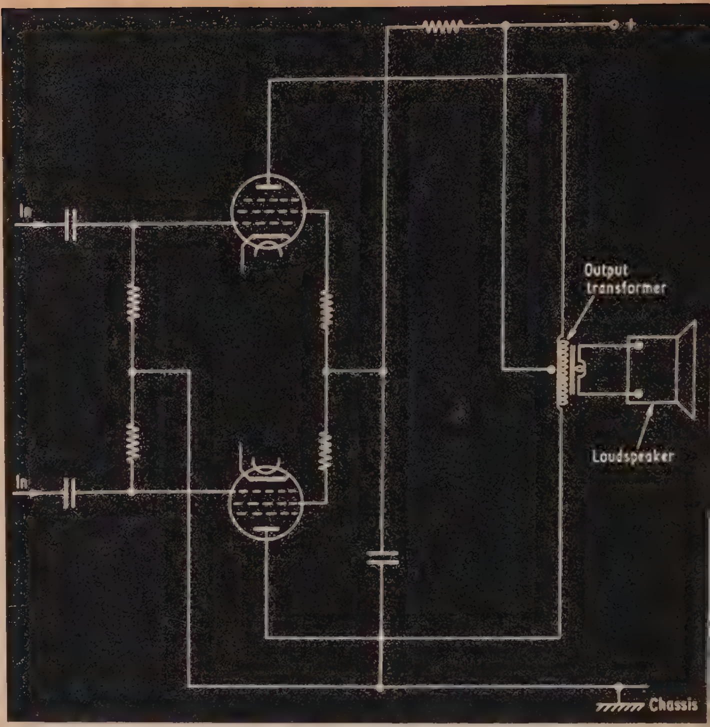


Fig. 3. Outline of the normal push-pull output circuit as used with pentodes or tetrodes.

Using a pair of pentodes in Class AB is fairly popular, with special circuitry to minimize distortion. Alternatively, by strapping the pentodes as triodes, conditions can be made to approach Class A and very low distortion levels result.

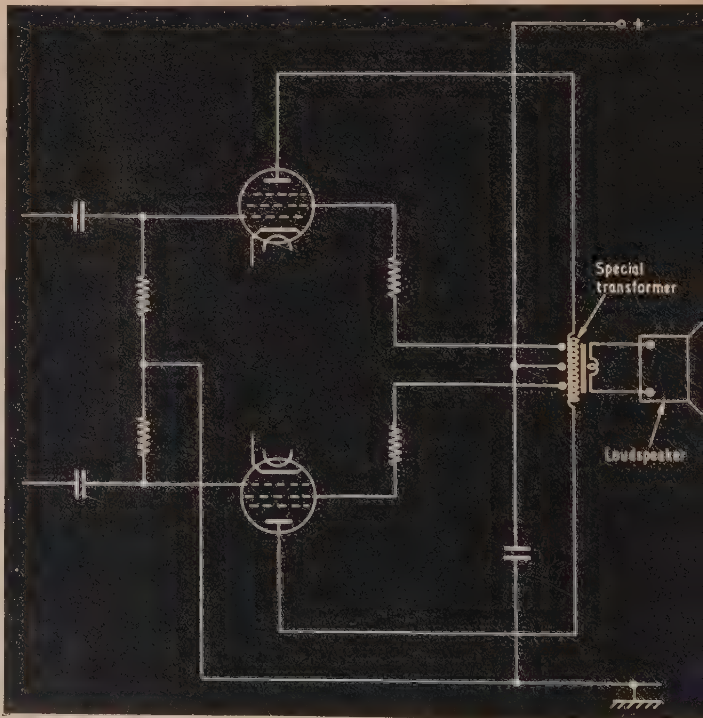


Fig. 4. In the ultra-linear circuit, special tappings on the output transformer are taken to apply feedback to the screen grids. The effect is to give results intermediary between triodes and pentodes.

More popular than either of these circuits, however, is the so-called *ultra-linear* output circuit. This involves feeding the screen grids of the pentode or tetrode output valves from suitable tappings on the output transformer. The resultant distributed-load operation is intermediary between triodes and pentodes, in which negative feedback is applied *via* the screen grids.

The best compromise between the power-handling capacity of the pentode and the low distortion and low output impedance of the triode depends on optimum setting of the tappings on the primary winding. In the case of valves rated at about 12 W dissipation (e.g. Mullard EL 84) 20% of the winding is made common to the anode and screen-grid circuits. At higher output powers—for example with 25 W dissipation valves such as the Mullard EL 34—the tapping is more commonly made at 43%.

DISTORTION IN TWO-VALVE OUTPUT CIRCUITS

Valve	*Mode of operation*	*Total Distortion* (%)		
		5W	10W	20W
EL 84	Triode	1·0	—	—
	Pentode	1·5	2·0	—
	Ultra-linear (20%)	0·8	1·0	—
	Ultra-linear (43%)	0·7	0·9	—
EL 34	Triode	—	0·5	—
	Pentode	—	1·5	2·5
	Ultra-linear (20%)	—	0·7	1·0
	Ultra-linear (43%)	—	0·6	0·8

The Output Transformer

As valves and other components have improved, the use of a top-grade output transformer is now mandatory—making it the most expensive item in the amplifier. A heavy iron core is necessary to produce the requisite primary inductance for good low-frequency response. Leakage inductance must then be minimized to preserve response at very high frequencies and to avoid excessive phase shift. The latter effect can seriously restrict the volume of negative feedback which may be applied without instability. Distributed capacitance in the windings, too, creates an inevitable peak due to resonance with the leakages just mentioned.

Higher permeability cores have been made possible by using grain oriented strip—the "Unisil" cold-rolled silicon steel—or the "C-core". This has allowed some reduction in weight and size. Toroidal construction is used in a few cases, and reduces stray hum fields to very low values.

Damping Factor

Any tendency for a loudspeaker to vibrate at the natural resonant frequency of its cone will be effectively damped by the "braking" effect of the amplifier output impedance on the coil induced e.m.f. This damping is greater for low values of output impedance and so a special sort of "figure of merit" has come into use. It is known as the "damping factor" and equals the ratio of nominal load impedance to internal impedance. For example, at 15 Ω an amplifier possessing an output resistance of 0·5 Ω would have a damping factor of 30. This is a common practical figure.

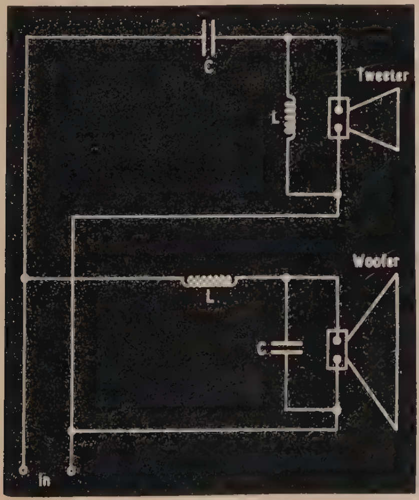
Transistor Output Circuits

Transformerless output circuits using power transistors have been introduced by one or two manufacturers of high-fidelity amplifiers, and may be taken as auguring a progressive move towards the use of transistors in all stages in the circuit.

Loudspeaker Drive Units

Conventional moving-coil drive units continue to form the basis of 95% of high-fidelity loudspeaker systems—using permanent magnets, of course, instead of relying on mains energization.

Improved magnet materials—notably Alnico and Alcomax, although barium-ferrite ceramic magnets are in use in the U.S.A. and Germany—give efficiency and transient response in less bulk. Changes in cone material, too, have taken place, so that moderately wide frequency response is obtained from a single unit of say 10 or 12 in. diam., mounted in a well-designed enclosure.



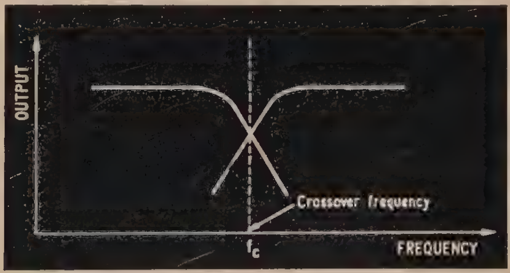


Fig. 5. The half-section filter is a popular network for feeding the speaker units in a two-way system. On the right is shown the general shape of the network response on either side of the crossover frequency.

The fact remains, however, that any sound source which is large enough to radiate low frequencies efficiently will be erratic and over-directional at high frequencies. This has led to the popularity of dual systems comprising, say, a 12in. l.f. speaker (woofer) and a 5in. h.f. speaker (tweeter). Each unit can then be designed to give efficient coverage of part of the spectrum, and is fed by an appropriate frequency dividing network.

This process has been taken even further in three-speaker and four-speaker systems. In addition to the combining of separate units, there have evolved a number of so-called coaxial units and here the large bass speaker has a complementary high-frequency unit mounted on its axis, the combination, plus the requisite crossover network, being supplied as a package deal. The advantages of this are that: (i) mounting of a single component only is necessary, (ii) the correct choice of crossover frequency and slope has been made by the designer, and (iii) high and low frequencies emerge from the same point in space. Triaxial and tetraxial designs have also appeared, in which two and three tweeters are fastened in front of the main speaker cone.

In many cases, high-frequency drive units are electrostatic (and sometimes ribbon) instead of moving coil. In the electrostatic loudspeaker, a high d.c. supply is used to set up a fixed attractive force between two plates. The signal voltage is then superimposed on this polarizing voltage so that a fluctuating force applies. One of the plates takes the form of a thin light diaphragm which vibrates and radiates the sound.

The very close spacing required for efficient energy conversion normally restricts the use of electrostatic speakers to high frequencies only. However, there is one notable British full-range system—the Quad electrostatic—which has become a firm favourite with many high-fidelity enthusiasts.

Loudspeaker Enclosures

A wide variety of enclosure types is met in high-fidelity systems—the choice and position within the room being very much a matter of personal taste. The flat baffle loudspeaker (of which the open back cabinet is an extension) has radiation properties similar to that of a dipole, and loses efficiency at sound wavelengths longer than the baffle diameter.

The "infinite baffle" cabinet consists of a totally enclosed box, containing acoustic damping material to absorb the energy from the rear of the cone. Perhaps the most popular are the bass reflex and folded horn cabinets each of which endeavours to utilize the back radiation by returning it to the room in phase with the frontal wave. This has the advantage of potentially more extended response at low frequencies.

To sum up, the high-fidelity reproduction of sound requires a high quality signal—derived from the best available discs, tapes or radio transmissions—picked up by well-designed transducers or tuner units and amplified through special circuitry using, for the most part, close tolerance components. The avoidance of distortion and the preservation of a high signal-to-noise ratio make it imperative that each unit is properly matched to the next, and this is true even of the loudspeaker/room combination since the room may be said to act as an extension of the loudspeaker enclosure itself.

International Conference on The Physics of Semiconductors

This Conference is to be held at The University of Exeter, Devon from 16-20th July, 1962 and is planned to follow the previous sequence of conferences on the "Physics of semiconductors" held in Reading 1950, Amsterdam 1954, Garmisch 1956, Rochester 1958 and Prague 1960. It is being arranged by The Institute of Physics and The Physical Society under the auspices of The International Union of Pure and Applied Physics and the British National Committee for Pure and Applied Physics of the Royal Society.

As with previous conferences, the emphasis is on the fundamental physical properties of electronic semiconductors and not on their applications. In view of the 1961 Durham conference on "Thermo-electricity", this aspect of the subject will be treated less fully than others. It is planned to exclude considerations of alkali halides, radiation damage, luminescence and photoconductivity, unless such work discloses new fundamental information of general interest. Sessions so far proposed are on transport properties, optical phenomena, effective mass determination, lattice vibrations, magnetic properties (including resonance), and disordered semiconductors. Each of these sessions will start with an invited review paper—during the presentation of which there will be no parallel sessions in progress. Other sessions will be run in parallel, when such topics as surface effects, materials, band theory and recombination will be considered.

The University of Exeter occupies a pleasant parkland site and most of the Halls of Residence are within a few minutes walk of the lecture halls. It is expected that the delegates (and wives) will stay in University Halls of Residence. Single and twin-bedded rooms are available, and the fees for the Conference will be in the region of £20.

The opening address will be given by Professor N. F. Mott, F.R.S. Among those who have agreed to attend and to contribute review papers or to act as Chairman are: D. Polder, G. Busch, W. Cochran, J. Tauc, M. Matyas, B. Lax, B. Vul, S. Kalashnikov, W. Shockley, P. Aigrain, L. Sosnowski, W. H. Brattain, J. Bardeen and H. Klinger.

People wishing to present papers will be asked to submit three copies of their abstracts by 1st February, 1962, and the final papers by 1st June, 1962. Keeping to this timetable will enable the *Proceedings* to be published speedily. Presentation time of contributed papers should not exceed twenty minutes, and a discussion time of ten minutes will be allowed for each paper. Authors submitting papers will be notified of their acceptance or otherwise by 1st April. Offers of papers should be addressed to Dr. C. A. Hogarth, Brunel College of Technology, London W.3.

General correspondence on matters of administration and applications for attendance should be addressed to: The Administration Assistant, The Institute of Physics and The Physical Society, 47 Belgrave Square, London S.W.1.

"Tesamoll" is a comparatively new material which has found considerable use and a permanent place in the manufacture and assembly of electronic, radio, electric and engineering components. It is manufactured by Sealdraught Ltd.*

SELF-ADHESIVE URETHANE FOAM

A Valuable Accessory for the Electronic Engineer

BY A. R. DOLMAN,
A.M.I.Mech.E., A.M.Inst.F.

SELF-ADHESIVE FOAMS are principally used for the special characteristic of the urethane foam itself while the p.v.c. carrier and the pressure-sensitive adhesive make their use and application easier and more practical. To value this particular product, one must consider it in three ways because of the three separate elements which go to its construction. These are the urethane foam, the p.v.c. carrier base and the pressure-sensitive adhesive.

Let us first consider the urethane foam which is formed by mixing together a liquid alkyd resin, a di-isocyanate and some free water. The resulting action is rather reminiscent of the bakery; broadly speaking, carbon-dioxide is released and creates an expansion within the mixture which causes it to grow into a spongy mass. Proportions and conditions can be varied to produce foams of a wide range of densities, resiliency and flexibility. The grade selected for the self-adhesive type for industry has a small, open-cell structure with a density of 2·8 lb/ft^3 $\pm 10\%$, and it is the particular characteristics of this grade which has found so many applications.

Before going further with the qualities of the foam it is better that the p.v.c. carrier tape and the pressure-sensitive adhesive and their qualities should be considered first, as both these components define the limitations of the complete material to a greater degree than the foam.

The urethane foam is usually laminated to a carrier or support of p.v.c. film 0·0015 in. to 0·0016 in. thick which has a tensile strength of 22–30 lb/in. of width. This question of lamination is an important one, as, in the best self-adhesive foam of this type, the chemical lamination of foam to the p.v.c. film carrier is carried out in the same machine which coats the pressure-sensitive material on the back.

The manufacturers of "Tesamoll" claim that foam chemically laminated in this way cannot separate from the carrier film. The lamination process is very different to the physical or mechanical method, where the foam is simply rolled into contact with double-sided tape, when the adhesion is purely a pressure-sensitive one. In this case the adhesion of foam to carrier is subject to deterioration because the porous nature of the foam allows the adhesive to dry out and because actual adhesion is only to the fine edges of the cells. Self-adhesive foams of this type do not last and usually show their weakness under test by stripping easily and cleanly off the carrier film.

Certain types of self-adhesive foams replace the p.v.c. carrier with a double-sided paper tape but these are generally unsatisfactory as they do not handle well, break easily in use and have a very short life, especially if not under continuous compression.

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* Chandos House, Buckingham Gate, London, S.W.1.

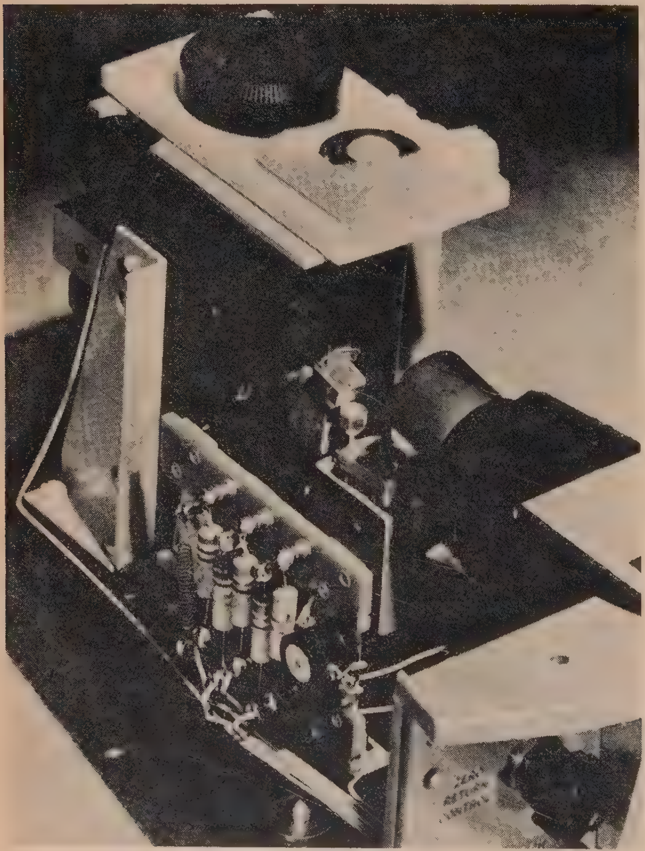
The p.v.c. carrier film plays an important factor in that it gives the foam stability and restricts its elongation to the limits of the film. This ensures that the physical structure of the open cells remains constant—which is essential if the characteristic compression/density ratio of the foam is to be retained—and if the foam were to be stretched this important factor would be changed. The p.v.c. film is, however, sufficiently elastic for the foam to be positioned with ease and to allow for a certain degree of irregularity of shape and surface.

As a carrier film, p.v.c. has another important advantage over paper in that it is waterproof and so protects the pressure-sensitive adhesive to a much greater degree when the material is in position, against the action of water, solvents and ageing. The powerful, pressure-sensitive adhesive is coated on the reverse side of the p.v.c. carrier, where it is masked and protected until required, by a special, orange coloured and corrugated p.v.c. film which peels off easily as the foam section or strip is applied.

When water, solvents or heat are present, it is found that the limiting factors of self-adhesive foams are determined by the reaction of the p.v.c. carrier and the adhesive rather than the characteristics of the foam. The carrier itself is resistant to mineral and vegetable oils, alcohols, petrol aliphatic hydrocarbons, and many of the acids, weak or concentrated, as well as ozone and oxygen. The effect of gaseous and liquid chemicals on the adhesive mass is not so easy to determine. When the foam has been stuck down, the p.v.c. carrier gives considerable protection to the adhesive, though, of course, the edges are vulnerable to the penetration of gases and light, volatile oils. In these situations, it is recommended that practical tests should be made. It is claimed that water has little effect on the adhesive once the material has been firmly bonded down. This, of course, only applies to those materials where there is a chemical lamination of foam to a p.v.c. carrier.

The bonding of the foam to its carrier film is generally unaffected when there is a chemical lamination to the p.v.c. film but material which is made by mechanical adhesion to a double-sided tape, either p.v.c. or paper, is seriously affected by solvents and gases with the result that the foam parts from its base almost immediately or in a matter of hours or days, depending on circumstances.

The actual foam has many interesting physical and chemical characteristics. It is odourless and non-irritating. Being made from synthetic materials, it is rot proof and will not support fungoid or bacterial growth and is unattractive to insects and vermin. Exposure to light, oxygen and ozone has little effect on the foam except for a darkening in the light coloured and white grades. It is electrostatically negative and tends to repel dust and other gas or airborne particles.



As can be seen in the smaller picture the "Slow motion zero" head and the "Spirit level" both protrude through the casing of the instrument. The use of urethane foam to seal against the entry of dust saved considerable, complicated engineering and expensive fitting. The gentle "push back" characteristic of the foam had particular value in this case as it made a dust seal without exerting undue pressure on the instrument or its case.
There is practically no limitation to the size and shape of gaskets and seating which can be stamped from self-adhesive foams. They have been used in cameras, balances, electronic and scientific instruments as seatings, shock absorbers and dust excluders. Strips of self-adhesive foam, supplied in rolls, are available in a wide range of stock thicknesses and widths. Alternatively, they can, if necessary, be cut to special widths up to a maximum of 18 in. wide. White is the most used colour, black being used where light proofing is an additional requirement.

Small amounts of shock or vibration can cause problems with delicate instruments. In some cases it is necessary to isolate the vibration of a unit from the rest of the instrument, and in other cases the component itself may need protection. Strips of self-adhesive foam or a complete covering of the base can be used. The foam can be cut to shape and if the number of components is large special shapes can be pre-stamped. Self adhesion makes assembly easier.

Physical characteristics (applicable to urethane foam only) are as follows:

Maximum service temperatures:
Continuous 212°F, dry heat; or 140°F, wet heat. Intermittent, 250°F.

Melting point: 450°–500°F.

Minimum service temperatures: No reliable information as to limiting factors in lower temperature ranges. Tends to stiffen at 32°F (freezing), with increasing loss of elasticity roughly proportionate to decrease in temperature. Complete recovery of elasticity on defrosting from 32°F.

Tensile strength: 9–13 lb/in.^{2}

Thermal conductivity: 0·2–0·25 BTU/ft.^{2}/hr/°F per in. of thickness.

Absorption coefficient: Up to 92% at frequency of 5,000 c/s.

Elasticity and compression: Ratio of compression/density of foam is shown to be considerably higher than for latex foam. Stress/strain curves show that after initial resistance there is a rapid rise of strain for negligible increase in stress. Finally stress rises sharply as urethane cells close completely. Elasticity of the foam is lower than that of latex foam, and recovery is slower by comparison. This characteristic of urethane of this density is important to industrial users in that there is less "push-back" for soft cushioning and vibration damping requirements.

Structure properties:

(1) The foam is of interconnected cellular construction and is therefore flushed with air at every compression cycle. Thus it does not tend to harbour dust or germs. Owing to its sponge-like nature, the foam will hold water, but there is no capillarity effect.

(2) So far as is known the foam has no toxic effect on humans, and physiologically is virtually inert.

(3) The foam is translucent to X-rays.

Electrical characteristics:

Dielectric strength: 17·5 kV/cm at 50 c/s 70°F.
15 kV/cm at 50 c/s 91°F.

Specific resistance: at 1,000 V 86°F–10^{11} Ω cm.

Loss factor: 0·01 at 10 c/s.

Dielectric constant: 1·3 to 2·0 at a temperature range of 59°F–257°F.

Chemical reactions:

The following can only give a general indication of the reaction of the foam when in contact with various chemicals. As previously mentioned the limiting factors chemically are the carrier and the pressure-sensitive adhesive. Self-adhesive foams with chemical lamination of foam to p.v.c. carriers, such as "Tesamoll", have a greater chemical resistance over other types of foams with mechanical lamination or paper support.

Chemical data:

With the exception of hydrochloric and hydrofluoric acids, immersion in up to 10% solution of acids has no effect upon the foam. Effect of concentrated acids is to cause swelling and/or complete decomposition. Weak solutions (below 5%) cause swelling only in the case of hydrochloric and hydrofluoric acids.

Concentrated caustics, soap solutions, salt-saturated water, mineral oil, linseed oil, bone oil, petroleum and paraffin oils have no swelling effects.

Solvents, such as acetone, ethyl acetate, carbon-tetrachloride, ether, carbon disulfide, toluene, etc., cause swelling of the foam in varying degrees from 10% to 100%. Esters, ketones, aromatic and chlorinated hydrocarbons, pyridine, benzene, nitrobenzene, etc., cause excessive swelling or decomposition.

While these notes give a rough guide to the chemical reactions of the foam it is generally recommended that

Strips of self-adhesive foam are being used as seatings for the diffuser of fluorescent lighting fittings. Not only is it easy to fit but it stays in position during assembly and also during maintenance of the unit when it becomes necessary to remove the diffuser for cleaning or a change of tube. Because of its easy compressibility with gentle "push-back" it takes up the difference between the tray and the diffuser without exerting undue pressure on either. Dust sealing in this way cuts down the maintenance time of the light unit.

tests under working conditions should be made where solvents exist or where there is any doubt of the capacity of foam, carrier or adhesive. The open-cell structure and its mechanical effect is perhaps of the greatest interest to the electronic, radio and electrical engineer, many of whom have found it particularly valuable as a dust seal and as a mounting to absorb vibration and shock.

When used as a dust seal for covers, inspection panels, escutcheons and at positions in a case where dials, knobs or operating wheels protrude, it quality of gentle "push back" has been found ideal as it seals by exerting only the minimum of pressure on the opposing components. as a shock absorber, the open-cell structure which has practically no pneumatic effect, again has a special and gentle result in that it absorbs shock without passing it on in any marked degree. Equally, there is comparatively less bounce or reciprocal action which makes it an excellent material as shock absorbing stops for the return points of levers or actuating arms. Its excellent acoustic and sound absorption properties make an ideal lining for instruments and cabinets and, because it can be cut to shape easily, it is ideal as a sound-absorbing fill-in between components.

The pressure-sensitive self-adhesive which is very powerful and sticks instantly to practically any smooth, clean, dry surface is more interesting to the production or methods engineer who will appreciate its time saving factor and capacity to simplify production. Self-adhesion makes positioning easier during manufacture and assembly, especially for complicated shapes and narrow strips.

The pressure-sensitive method of self-adhesion is quicker, cleaner and more positive than hand-applied adhesives and can often free a pair of hands for other work. Equally, it simplifies servicing of the finished products because gaskets and other fittings of foam remain adhering to either the component or the base and so do not get lost or damaged.

New Shaped-beam Tube

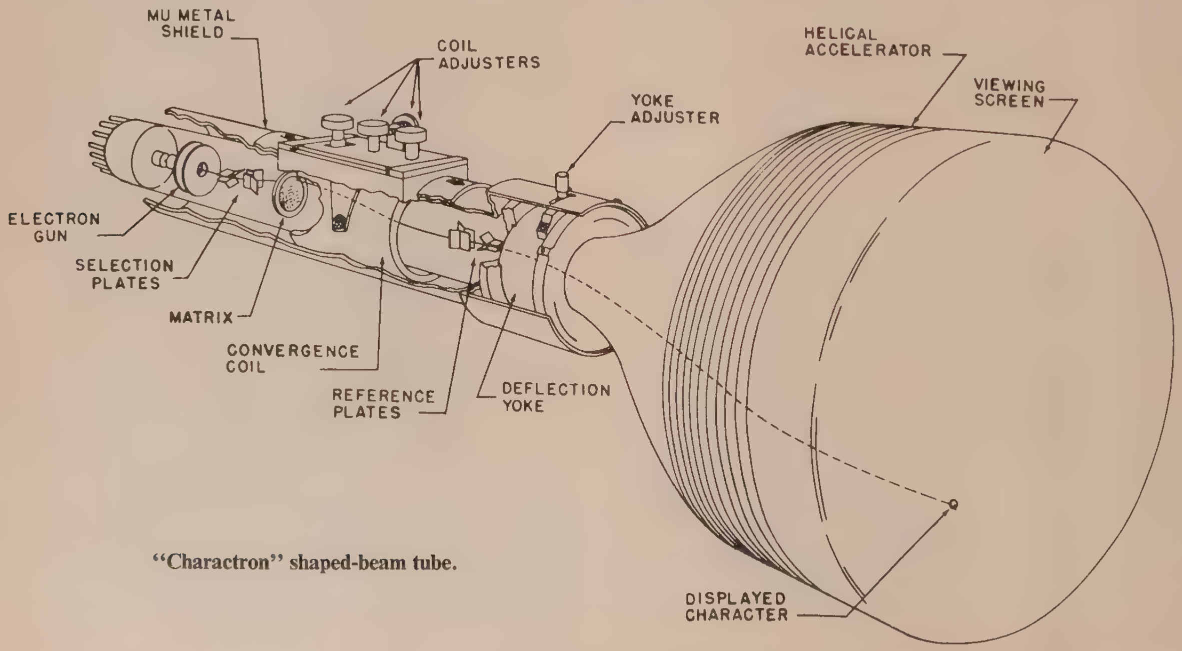
STROMBERG-CARLSON, a Division of the General Dynamics Corporation in the United States, has recently developed the "Charactron" a novel shaped-beam tube which can reproduce, by recording photographically, 1200000 tiny letters and numbers per minute. The new tube, designated Type C7C11, has a 7 in. diameter. The small size of the characters is said to enable the tube to reproduce nine times the information density (characters per square inch) of other models of similar description, vastly reducing the number of pictures required to show in permanent form the electronically-produced letters, numbers and other symbols.

Each character can be reduced to a height of 0·035 in., and ten thousand can be reproduced for photographing in one frame. They can be arranged in the form of 100 lines of 100 characters each and the tube is said to display characters at a rate of 20000 per second.

Characters appear on a screen 4½ in^2. within a 6 in. circle.

The tube utilizes a stream of electrons to create numbers and letters at split-second speeds on a phosphor-coated screen, similar to the screen of a television set.

The tube reproduces the numbers and letters by directing electrons through a tiny metal stencil within the tube itself.



"Charactron" shaped-beam tube.

A cartridge containing a silcon carbide crystal being inserted into a tube.

"SOLID STATE" ELECTRONIC TUBE

It has recently been discovered that it is possible to obtain a constant flow of electrons directly out of the surface of semiconductor materials. A short description of the method is described, together with an indication of the possible applications.

DR. W. I. CHOYKE AND DR. LYLE PATRICK, research physicists of the Westinghouse Electric Company's Research Laboratories in the United States, have discovered how to obtain a constant flow of electrons directly out of the surface of semiconductor materials and how to put to practical use the new effect they have found in semiconductors, i.e. the unique crystalline substance from which transistors and other "solid state" devices are produced.

The latest semiconductor to yield this unique flow of electrons, is silicon carbide—a hard, crystalline solid which is best known for its widespread use, in impure form, as an abrasive in grinding wheels. The density of the electron flow is equal to that in the average modern electronic tube.

In recent years, transistors and related devices have replaced conventional electronic tubes in a wide variety of modern electronic equipment. By removing the most serious limitation of the ordinary electronic tube, this recent discovery in the United States might well reverse the current trend and bring a new lease of life to the very device which semiconductors seem destined to outmode.

An electronic tube functions by regulating the flow of a stream of electrons across an internal vacuum. Conventionally, these electrons are obtained by boiling them out of a coated metal wire, or cathode, at high temperatures. Considerable electric power is required to supply the necessary heat, which must then be dissipated to prevent overheating of the tube itself. Applied successfully to a vacuum tube, this new method of electron emission from semiconductors would do away with this whole inefficient process. It is possible to visualize a tube in which the usual heated cathode is replaced by a small semiconductor crystal having a built-in "junction" like that in a transistor. The crystal would consume a negligible amount of power and would yield electrons instantly and indefinitely when a small electric voltage is applied across it. Such a device would, in effect, combine into a single operating unit many of the inherent advantages of both semiconductors and vacuum tubes. In point of fact, it would become a "solid state" electronic tube.

The escape of electrons from silicon carbide accompanies the emission of visible light from the crystal. The visible light is a form of electroluminescence, and occurs when enough voltage is applied across the junction to cause breakdown, i.e., loss of the junction's normal electrical resistance. When breakdown occurs, small blue spots of light appear in the crystal in the region of the junction and electrons escape from these bright, light-emitting spots—especially from those located nearest the surface of the crystal.

The spots are small, only about 50 millionths of an inch in diameter, and currents have been measured from these up to one-millionth of an ampere, which indicates that the density of the electron flow is quite comparable to that from the cathode of a typical vacuum tube.

Although a millionth of an ampere is a small current by everyday standards, many of the more sophisticated electronic tubes of today, such as beam-type camera and display tubes used in television electronic systems, may use considerably less current than this.

It is particularly interesting to note that this adequate flow of electrons originates from a tiny, pin-point source. Such a source would have many advantages in the construction of complicated tubes. It would simplify focusing of the electron beam and eliminate much of the complicated tube construction now employed for this purpose. In view of the present-day emphasis upon miniaturization of electronic equipment, elimination of the large, hot, power-consuming cathode would be a major advance in electronic tube development.

The potential advantages of such a "solid state" tube has stimulated further research on the electron emission from silicon carbide as well as a programme aimed at making eventual use of the phenomenon in working devices.

OPTICAL RESEARCH

In the Sound Recording Industry

Contribution of Optical Methods to the Development of Compounds without Background Noise for High-fidelity Microgroove Gramophone Records

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It was the advent of the long-playing gramophone record, without any question, which led to the extraordinary world-wide expansion that has marked the development of the sound-recording industry.

Vinyl copolymer resins have made it possible to obtain a record which is light, unbreakable, long playing and of high fidelity. This is due to the fineness of moulding of the grooves which is possible with these resins and to the suitability of their properties for high-quality sound reproduction; in other words to the improvement of moulded surfaces following upon new formulations of compounds.

Parallel with this evolution, great progress has been made in recording and reproducing equipment. The improvement in quality of sound reproduction gave an acute urgency to the problem of the suppression of "crackling", "knocks" and other parasitic noises which may be grouped under the term "background noise".

The object of this article is specifically to report on a little-known field of work in the researches which have already contributed to a large extent and in decisive manner to the development of new resins and compounds for the sound recording industry.

1. THE PROBLEM OF BACKGROUND NOISE

LIMITS to the increased playing time associated with micro-groove records are set by artistic as well as by technical considerations. When records are played back, the sounds deliberately recorded are in fact not alone, but are accompanied by a number of parasitic noises (hissing, crackles, clicks etc.) which interfere with the reproduction. The weaker the signal picked up, the more troublesome these noises become.

Apart from noises mentioned above, there are other background noises to which the ear can become accustomed, but these become more audible when the high frequency response is increased in the quiet passages. These are mostly continuous (needle noise and surface noise), but are sometimes intermittent (crackles). They often affect a particular sector of the disc, and their appearance at regular intervals makes them all the more annoying. Cracklings are an expression of local imperfections distributed at random and for the same reason are the more vexatious if they stretch across several grooves. The amplitude of background noises has changed with the mechanical progress in the fineness of grooving (up to 14 lines per mm) and playing at low speeds of rotation (33 and 16 rev/min), and it is vitally important to be sure of their origin if one is to diminish or suppress them.

Researches with this purpose, which have been carried out for several years by the Centre de Recherches d'Aubervilliers of the Péchiney Company, and which have resulted in the production of resins and compounds free from background noises, have been based essentially on optical methods; audio-electronic methods only lead to registration, or at most to measurement of the background noises without any possibility of identification.

Reason for Choice of Methods Used

Existing electronic methods have recourse to visual inspection and audition. The basis of the results obtained with these methods depends on the exploration of the groove with the help of a conventional needle-type pick-up.

Defects in these methods are outlined in the following observations:

(*a*) It is difficult to keep a record in its original condition as it does, of course, wear progressively during the period of investigation. The problem of the cleanliness of the surfaces during storage is also a disturbing factor.

(*b*) The methods which appeal to the ear are too subjective and require an artistic training not necessarily to be found in a laboratory.

(*c*) It is difficult to store an impression of a result obtained for future consultation without having to put into operation a heavy and delicate apparatus under precise conditions which are difficult to reproduce.

Methods of optical investigation, on the contrary, allow us to take into account only the visual acuity of the operator. Comparison between two results is possible by use of photographic recording, and the storage and frequent consultation of the results is easy.

Finally—and this is a very important advantage which could alone justify the use of such methods—it is possible to classify different faults according to their origins and their importance. This allows us to determine the probable causes, and to act upon some of them with certainty.

2. METHODS OF EXAMINATION

A parasitic noise always manifests itself at the level of the faces of the groove by surface irregularities which one must be able to examine. The study therefore resolves itself into an examination of a filled or not completely filled record groove (M. T. Gifford, P. C. Woodland, and R. B. Dahl, Modern Plastics, August 1957), of the surface state of the groove, or—in certain cases—of the virgin record material at the centre of the disc.

Any surface structure will cause parasitic noise *a priori* if it causes the pick-up to vibrate below 12,000 c/s. This frequency corresponds to a mean grain structure of 30μ on a disk played at 10 centimetres from its centre at 33 rev/min. It is obtained with a finer grain on a slower-speed record or, indeed, of the same order or even coarser if one considers the harmonic frequencies of a basic parasitic low frequency.

These calculations show that observation of the parasitic granulation of a surface (of record or matrix) when present, would lie within the domain of optical microscopy. We shall see experimentally that such observations demand the equally essential support of electron microscopy.

This leads us to set out the different methods used in research on this granulation or grain and, in a much more general way, on all defects which may concern the fidelity of recording.

Ocular Examination

This method of examination shows up the most obvious faults such as bad pressings, scratches, spots or hard particles. In carrying out the examination by means of tangential reflection it is, moreover, possible to make useful observations on the texture of the compound from which the record is made, up to the limits of the resolving power of the eye, by the focusing of the eye on the disc surface.

Examination with Binocular Lens

The advantages of the binocular lens are the stereoscopic view, a great depth of field and the large surface provided for observation. It is, however, a specialized examination requiring considerable experience, particularly in the study of the state of surfaces.

Examination with Optical Microscope

The episcopic observation of gramophone records is limited by the weak reflecting power of plastics in general and their low tolerance to the heat of a long and intense illumination. At a high enlargement, observations can in fact only be made by diascopy, beginning with transparent replicas.

A new method of investigation consists of studying the compound in the mass, starting with thin sections obtained by microtomy. This method allows evaluation of the distribution of carbon black, the possible presence of a superficial skin, of heterogeinities, of zones of flocculation, fissures etc. The heterogeinities are identified by combining the physical methods of microscopy (birefringence, fluorescence, refractive index, microhardness) with chemical techniques (microdissolution, microfusion, microcalcination etc.).

Examination with the Electron Microscope

Non-metallic surfaces have to be examined in the electron microscope by the intermediary of ultra-thin replicas transparent to electrons, at magnifications which may exceed ×100,000. The preparation of these replicas, less than 0·1 μ thick, involves the use of new developing techniques associated with electron microscopy—some of which by now have already become conventional, such as vacuum evaporation and poured plastic films.

In the *single stage or negative* replicas method, one forms the electron transparent replica either:

(*a*) by evaporation of a very dilute solution of resin (collodion gelatin, ethyl cellulose) on the specimen which must be extremely soluble so that it can be dissolved away, or

(*b*) by thermal evaporation *in vacuo* (10^{-4}mm.Hg) of a metal (Si, Ti) a light oxide (SiO, SiO_2) or, as is more usual today, of carbon.

In the case of gramophone records, it is immediately evident that there must not be any swelling on dissolution, or the replica may be destroyed. The organic solvent should, moreover be incapable of action on the imprinting resin and similarly the imprinting resin solvent should be incapable of action on the record at the time the replica is made. Finally, in the case of a mineral replica, the resin should resist the heat of thermal evaporation. As these conditions are not generally fulfilled in the case of plastic discs, one uses the *two-stage or positive* replicas method.

In this method, an ultra-thin film is formed on a rigid intermediate impression some tenths of a millimetre in thickness, which has been previously detached mechanically from the surface to be copied. The intermediate impression is obtained either by the hot moulding of a thermoplastic under pressure—in which case it may be very thick—by polymerization of an alkyl methacrylate, or more simply by the evaporation of a concentrated solution of resin. In the special case of records, intermediate impressions are made in polyvinyl alcohol, gelatine or gum arabic.

The diagram which sums up these methods (Fig. 1) shows that in plastics replicas, the differences of thickness are translated into an electronic image by continuous black photographic variations just as they are by level lines on mineral imprints. The relief is, in any case, reinforced by a shadowing technique which consists of vaporizing a metal (gold or palladium) or heavy oxide (UO_2) *in vacuo*, tangentially to the preparation or to its replica. The angle of shadowing is made to approach the horizontal when the differences in level are smaller, and the parts facing the source of metallic vapours receive more metal than the hidden parts. It follows that a lack of metal under these conditions is shown in the electron images by "shadows" showing light on a dark background.

One must remember that, in all these methods, each problem to be answered is a special case which may require much care and time in solving. It is for this reason that the interpretation of these electronic prints can only be made by those who know the exact process of replication used.

3. PLAN OF EXPERIMENTS

We shall first examine the general make-up of a record, in order to become well acquainted with the geometry of grooves and, hence, to be able to consider the zone of contact of the record with the pick-up head. We shall next review the principal defects which affect the fidelity of reproduction noticeably in the form of parasitic noises, whether these be occasional or permanent.

Geometry of the Groove and of the Stylus

The fineness of grooving and the width of the grooves can be measured with low magnification, either in incident or in vertical light (Fig. 2). Diascopic examination at high magnifications—normally from a groove replica, allows one to judge the moulding as satisfactory by the presence of a bright, strictly continuous strip at the base of the grooves (Fig. 3). The depth of the grooves can be measured at a very high magnification by the difference in the vertical focusing position between the edge and the base of the groove or at lower magnification by the episcopy of a section of the disc (at room temperature, this technique is only possible with polystyrene records) or by diascopy of the groove replica, broken radially and examined in profile.

The left half of Fig. 4 represents a new pick-up stylus—in this case a diamond—at the base of a groove of a 45 or 33 rev/min record. The end of the point (sapphire or diamond), distant at least 5 μ from the rounded base of the groove and having a radius of curvature of about 5 μ, ends in the form of a sphere of about 50 μ diameter. The margin of safety for strictly lateral tracking is thus rather slender. In particular, the limit is exceeded by the use of a worn stylus (right-hand side of Fig. 4). On the photograph which represents the tip of such a point (Fig. 5), the faces of the dihedron formed by wear on the terminal sphere of the sapphire against the sides of the groove are longitudinally oriented.

The central zone of this photograph corresponds to the part of the sphere situated immediately above the base curve of the groove. Its trapezoidal form is due to the slight leaning of the sapphire in the plane of axial symmetry of the groove, the small base of the trapezium placing itself in these conditions in the forward direction relative to the sapphire. The area of this zone decreases with wear of the sides of the sapphire up to the point where this tip bottoms on the curved surface at the base of the groove.

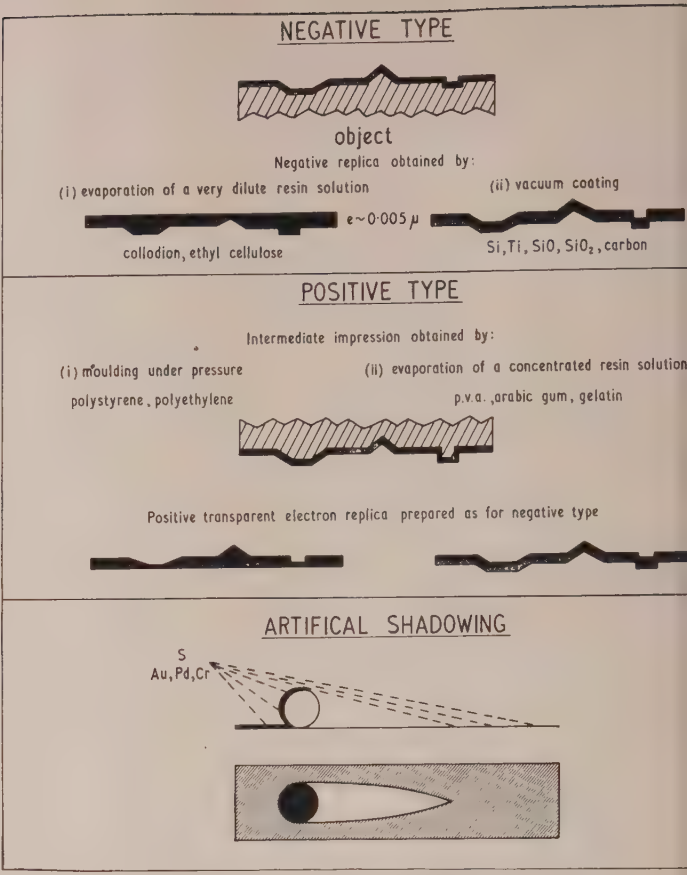
NEGATIVE TYPE
object
Negative replica obtained by:
(i) evaporation of a very dilute resin solution
(ii) vacuum coating
e~0·005 μ
collodion, ethyl cellulose
Si, Ti, SiO, SiO₂, carbon
POSITIVE TYPE
Intermediate impression obtained by:
(i) moulding under pressure
(ii) evaporation of a concentrated resin solution
polystyrene, polyethylene
p.v.a., arabic gum, gelatin
Positive transparent electron replica prepared as for negative type
ARTIFICAL SHADOWING
S
Au, Pd, Cr

Fig. 1. Methods of replication.

For a new stylus, the zone of contact with the side of the grooves is a band of about 15 μ halfway down the sides over the maximum measured width of the groove of 68 μ and against the edges of the groove at the minimum measured width of 42 μ (Fig. 6). This second value is thus difficult to reduce, without seriously compromising the tracking of the stylus, and thus sets an upper limit to playing time.

Structure of Surface

We call the "structure of surface" of a record all the elements of topographic nature, whether they arise from the imprint of the matrix, the natural texture of the resin, or even the conditions of moulding (lack of impression, hard particles, sticking). The standard surface structure of the face of a record (Fig. 7) carries various scratches, usually of a micro-size. An exact knowledge of the conditions of replication allows us to distinguish those scratches which come from the matrix (relief scratches) from those made on the disc subsequent to moulding (fingerprints, sapphire marks or marks from the use of a dirty cloth).

Study of Visible Defects which affect the Fidelity of the Recording

We will try to distinguish the defects which noticeably affect the fidelity of recording, in the form of occasional parasitic noises (localized defects), from those which affect it in the form of background noises (generalized defects).

Localized defects. The most common localized defect is undoubtedly the common scratch, which is a greater nuisance the deeper it is and the more micro-grooves it overlaps (Fig. 8). Keeping in the field of almost inevitable defects we may also note, particularly with regard to grooving, numerous grooving tool marks affecting the more pronounced incurved parts on the sides of the grooves (Fig. 9) notably in the course of recording high frequencies.

Fig. 10 shows another type of localized defect taking the form of streaks of all sizes distributed at random. The observation under the electron microscope of the elementary specks (Fig. 11) which constitute these depressions therefore aims at exaggerating their relief so as to separate faults due to the matrix, the material and the moulding condition. These spots, always hollow on the record, were thus related to micro-adhesions on the matrix. This has been interpreted as due to variations in viscosity due to non-uniformity of temperature during pre-heating of the pre-forms ("biscuits").

This type of sticking resembles impression faults (Fig. 12) generally connected with a too-rapid removal from the mould. Other defects of an entirely different origin preferentially affect the edges of the groove amongst which we may quote a high content of volatile matter in the resin and the accidental presence of traces of oil or grease on the biscuits (Fig. 13).

Finally certain records show, usually on one side of the groove, fine undulations practically parallel, which are parasitic below a certain incidence; it has been possible to link these directly with bad conditions of moulding (Fig. 14).

Generalized defects. The study of record compounds must at the start proceed empirically. We have already seen that difference of level in electron microscopy was indicated by shadowing, the shadow angle needing to approach the horizontal when the differences of level to be shown up are smaller. Angles of several degrees are sufficient for certain localized defects which we shall mention, and also for a type of generalized defect corresponding to an incompatibility between resin and stabilizer or lubricant (Fig. 15).

Such angles of shadowing are, however, too high to reveal certain structures shown only by very low shadow angles. In this way, the specific background noise of a type of resin in current use before the advent of high-fidelity resins has been directly related to the presence of a microstructure (Fig. 16) affecting the surface in the form of micro-granulation on the flat part of the disc and of micro-granulation on the sides of the grooves. This microstructure has been identified with a "de-mixing" of phases as is shown by the aspect of the same surface after selective etching (Fig. 17). The dependence of this mixture of phases with regard to background noise has been remarkably demonstrated by the considerable rise in parasitic background noise in an etched record.

Such a heterogeinity of the resin, which affects many commercial records, may be present in varying degrees and its incidence is immediately apparent from the degree of particularly gross heterogeinity on which our attention will be focused. Thus, the examination of a certain type of record with a binocular lens reveals coarse grain (Fig. 18) which can only be an internal effect, since the corresponding replica is free of any defect. This granulation, which can be found by microtomy, corresponds to a microdispersed coated phase mainly abutting against the base of the matrix grooves in the moulding. Fig. 19 shows that the background noise in these resins is not to be looked for in what may be a bad surface condition but wholly in the texture of the underlying layer which has a direct influence, at a distance of several microns, on the vibrations of the stylus.

The showing up of heterogeinity in certain resins is sometimes much more delicate and demands recourse to very special techniques of ultra-microtomy with sections of less than $1{\cdot}0\ \mu$ of thickness. It is this method which can be used to demonstrate incompatibility between p.v.c. and polymethyl methacrylate (Fig. 20).

4. APPLICATION OF QUALITY CONTROL TO RECORD COMPOUNDS

The problem of quantitative estimation of the homogeinity of compounds arising here when considering new formulae of mixtures for "high fidelity", has been resolved by means of microtomy.

In order to standardize the control, all examinations have been made by diascopy of thin sections ($20\ \mu$ of thickness) at an enlargement of $\times 10$. The sections were statistically selected from three samples cut with a punch from the last groove in positions at 120° one to each other. If the sampling is considered insufficient for a particular batch one may again multiply the number of pieces taken, starting from the same sample, and cover a specimen holder of approximately 20 cm^2 in area, corresponding to a surface of more than 20 slices of discs. The homogeinity of the resin is estimated quantitatively by interpolation by matching to samples in a photographic reference atlas. A view of part of this atlas (Fig. 21) gives some idea of the homogeinity of commercial record compounds as well as that currently obtained with the new Péchiney formulae (on the right-hand at the foot of the figure).

It is interesting to note that this measurement is carried out in less than half an hour, and that it is reproduceable to almost one point of the 8 of the atlas.

These microtomy techniques are, in fact, capable in well-determined cases of distinguishing, with acute sensitivity, the presence of a mixture of different resins,

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OPTICAL RESEARCH

In the Sound Recording Industry

Micrographs Figs. 2—21

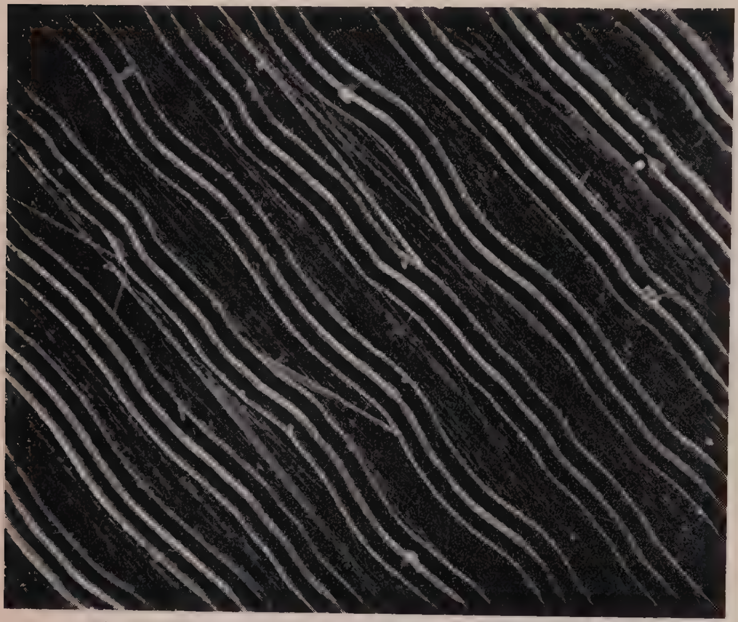


Fig. 2. Microgroove disc examined in incident light. (×100)

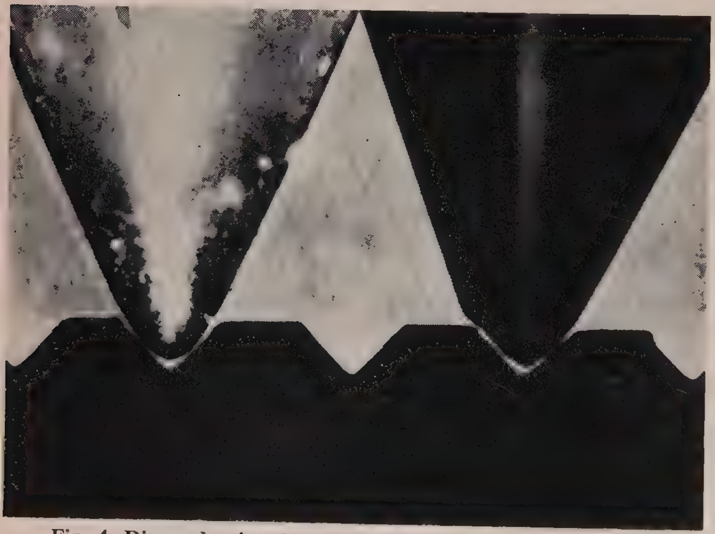


Fig. 4. Diamond points in the playing position. Left: new point; right: worn point. (×220)

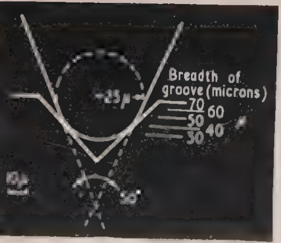


Fig. 6. Localization of the zone of contact between groove and sapphire in relation to the breadth of the groove.

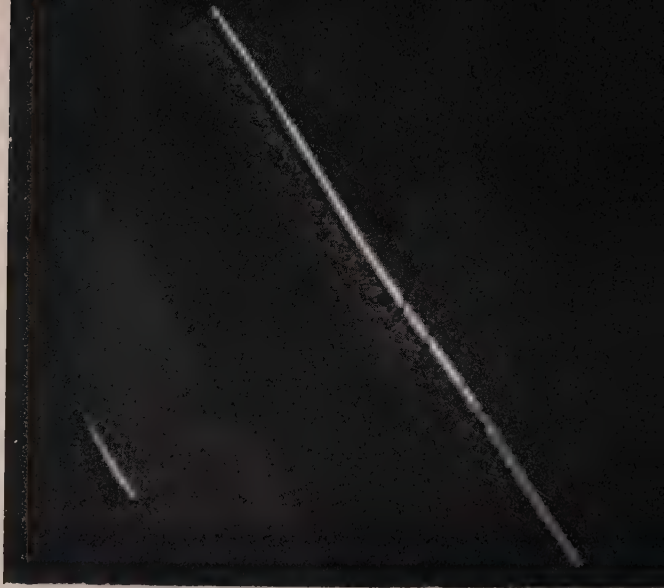


Fig. 3. Base of groove (bright strip) examined as a transpare replica. (×400)

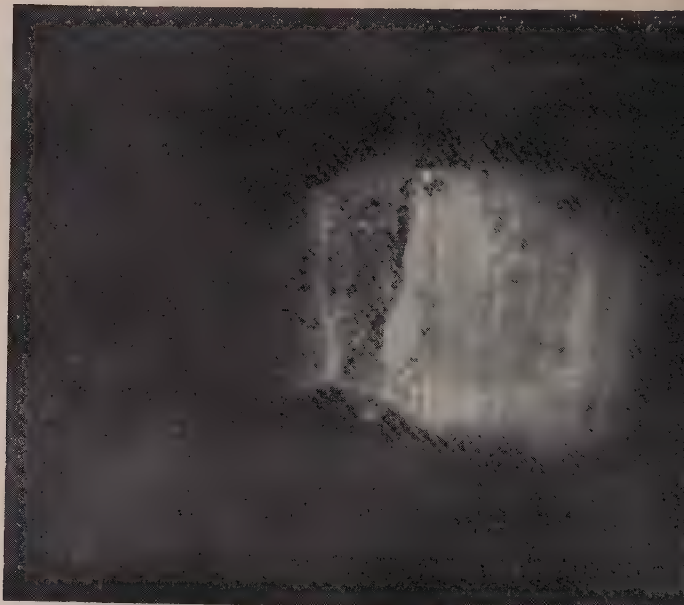


Fig. 5. Extremity of worn sapphire examined in incident light. The ax of the sapphire is nearly perpendicular to the plane of the photo. (×60

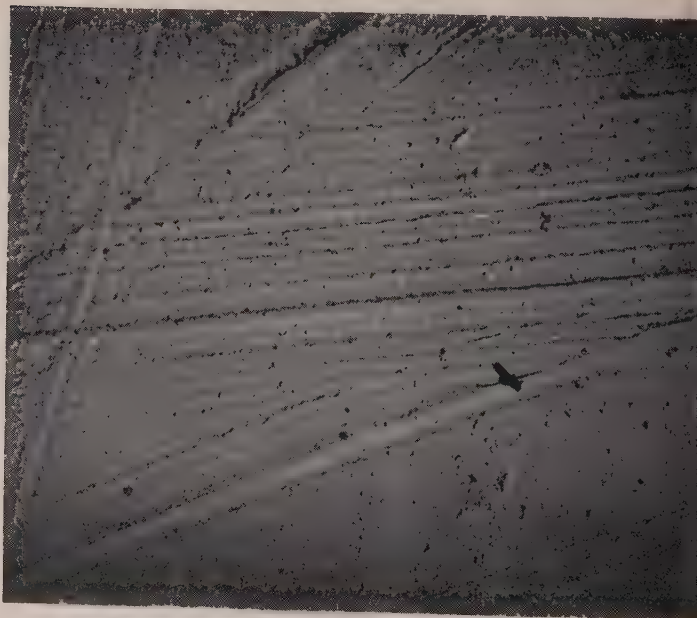
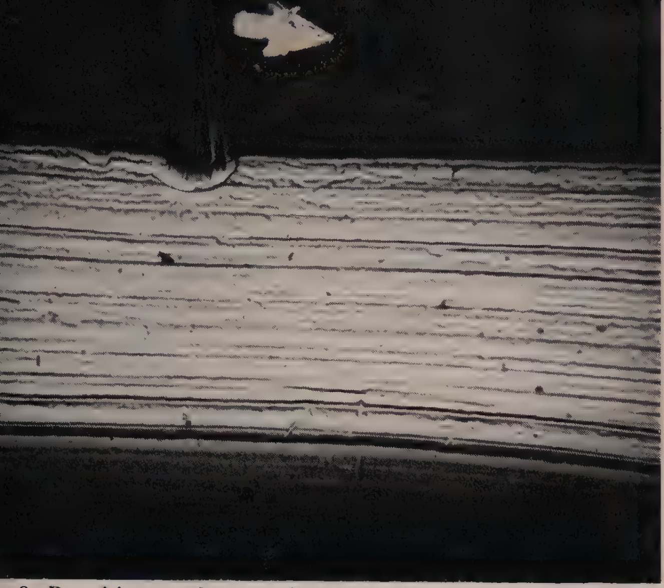


Fig. 7. Usual surface state of a microgroove record. (×3600)



. 8. Parasitic scratches stopping at the edge of the grooves. 1500)

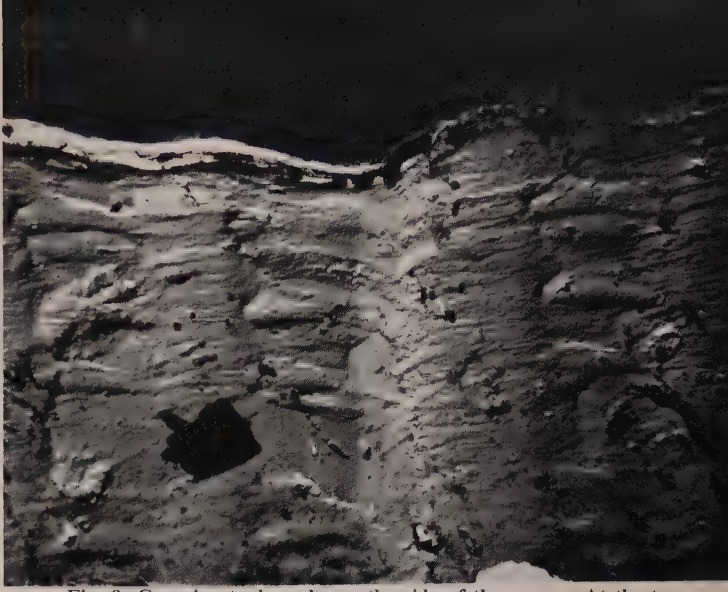
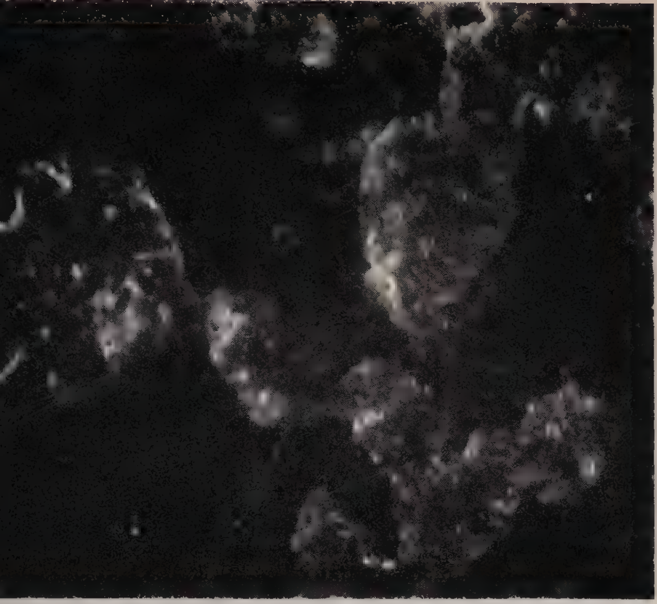


Fig. 9. Grooving tool marks on the side of the groove. At the top, virgin material. (×2000)



. 10. Superficial streaks which cause intermittent crackling. served in incident light. (×700)

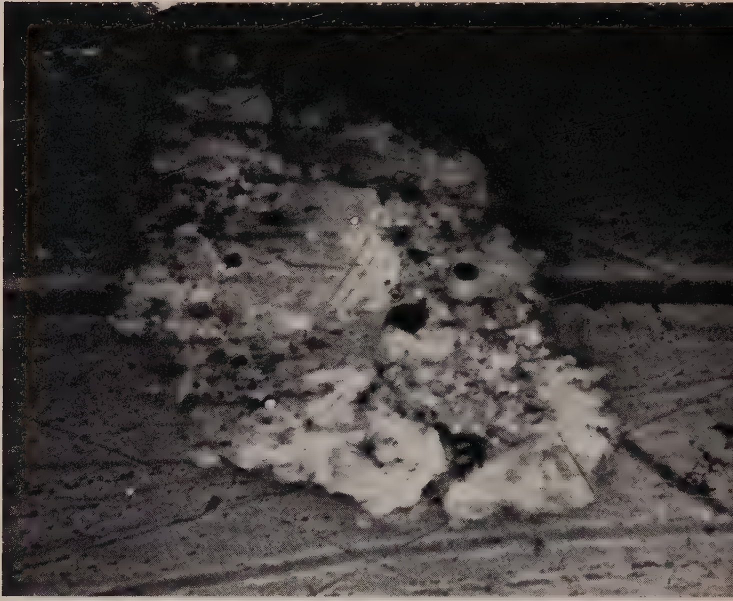
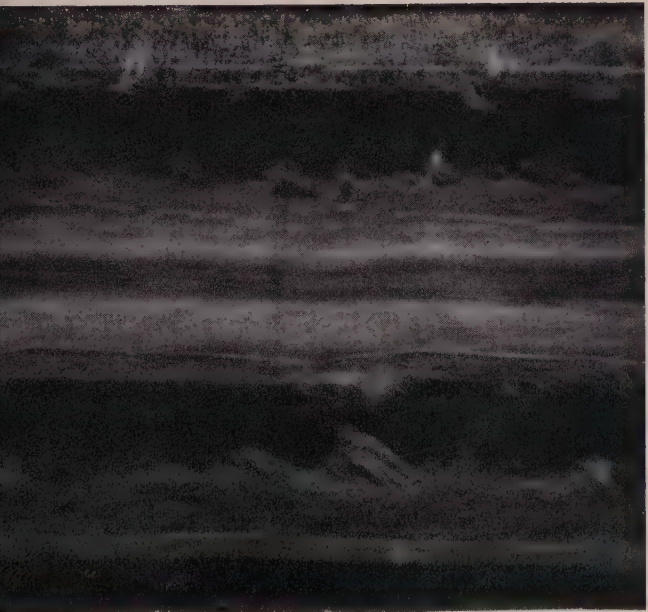


Fig. 11. Elementary defect (micro-sticking) giving rise to hollows (plastics replica observed in electron microscopy). (×6000)



. 12. Lost impression due to sticking and tearing: the edges of the ove (clear parts) are serrated. (×500)

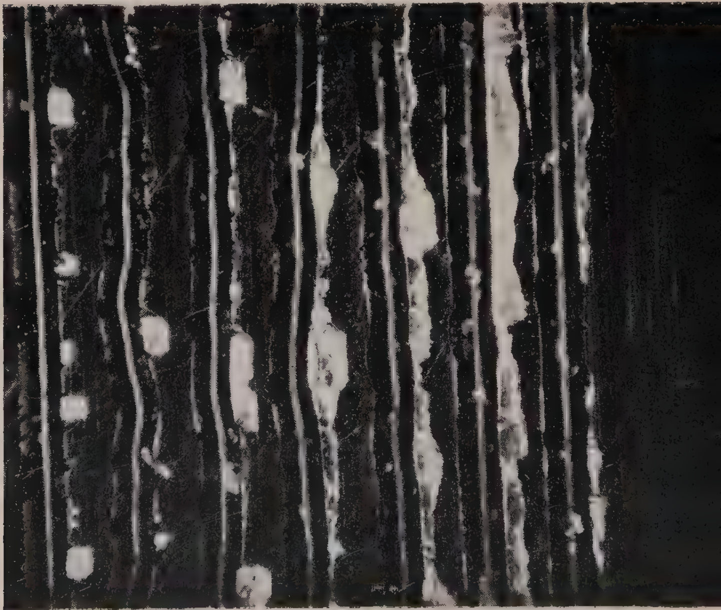


Fig. 13. Marks due to traces of oil which have fallen accidentally on to the moulding. (×90)

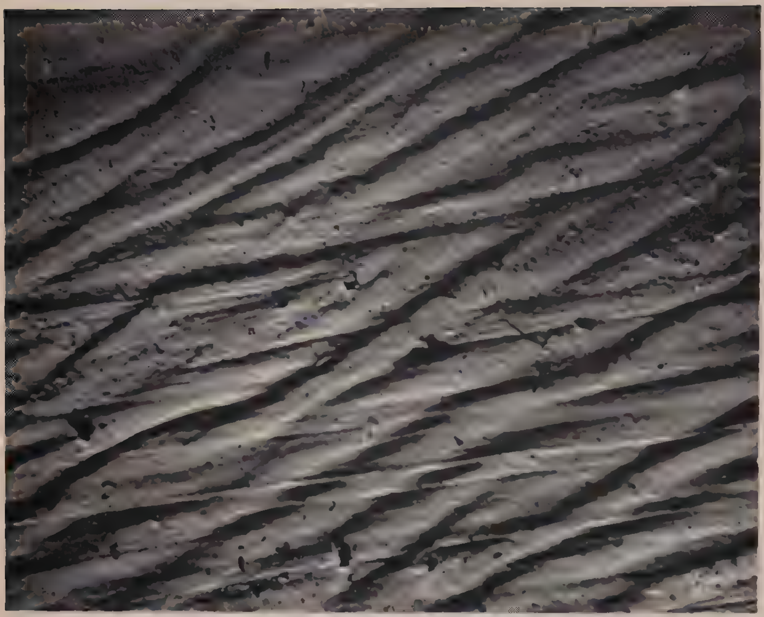


Fig. 14. Parasitic undulations preferentially affecting one side of the groove. One can distinguish horizontally the mark of the grooving tool or the stylus. (×4000)

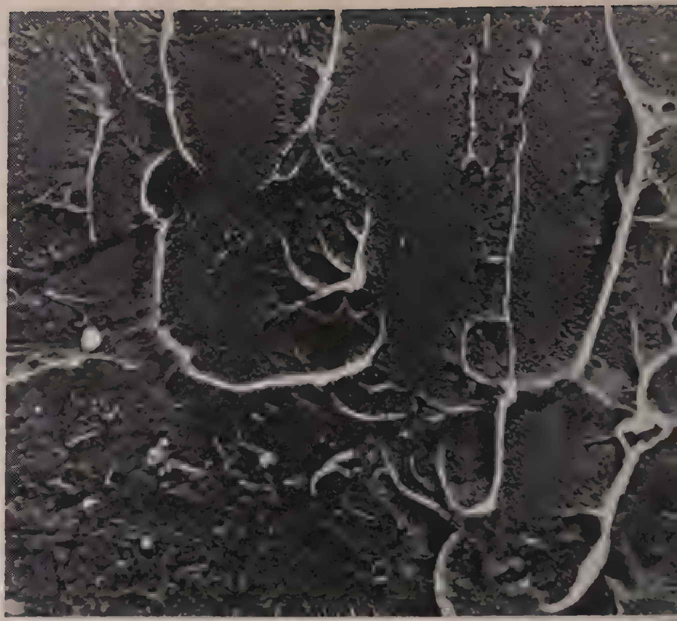


Fig. 15. Presence of incompatibility of a resin and its lubric (×20000)

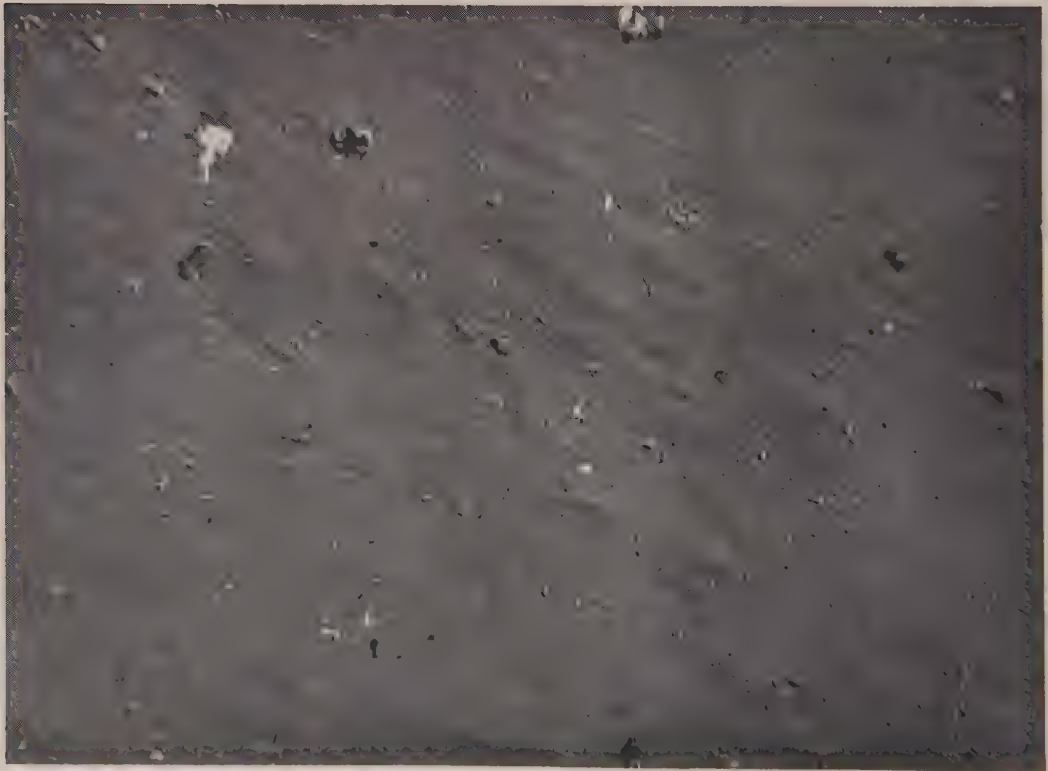


Fig. 16. Surface state characteristic of a disc giving background noise. (×3000)

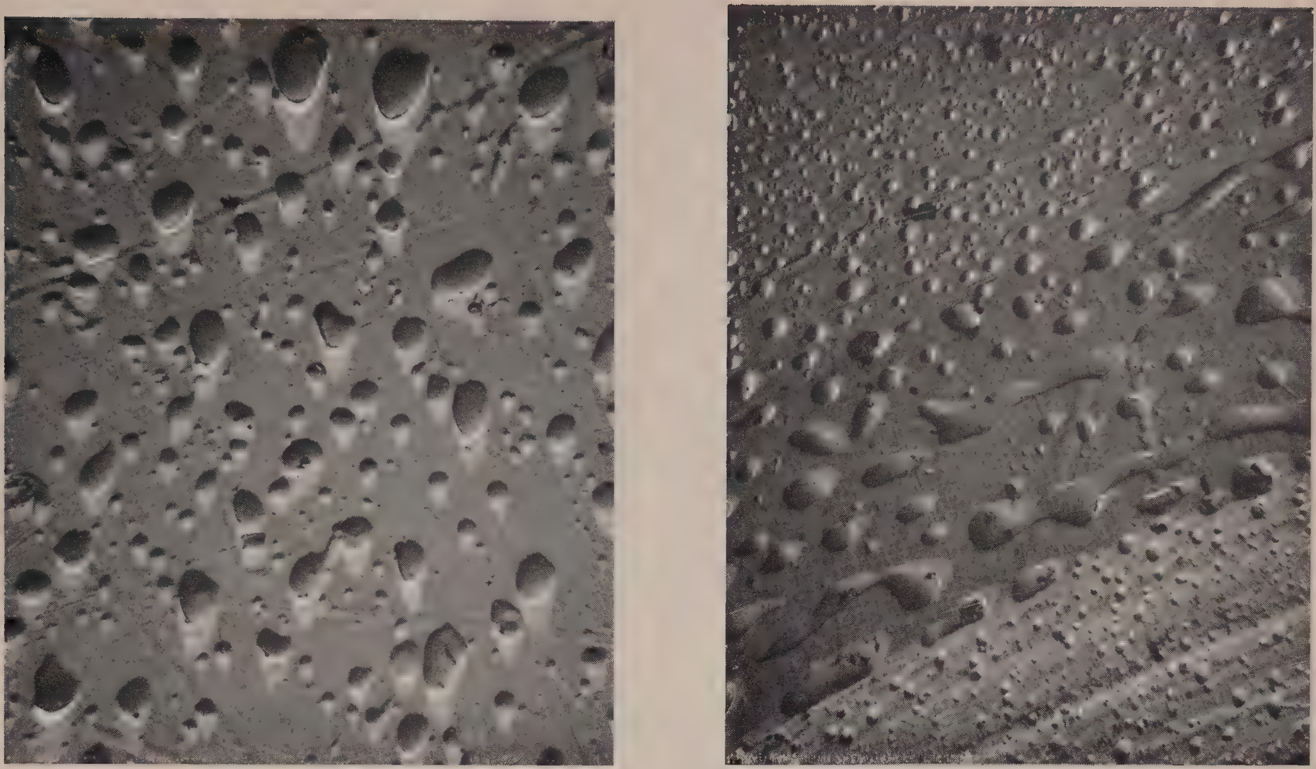
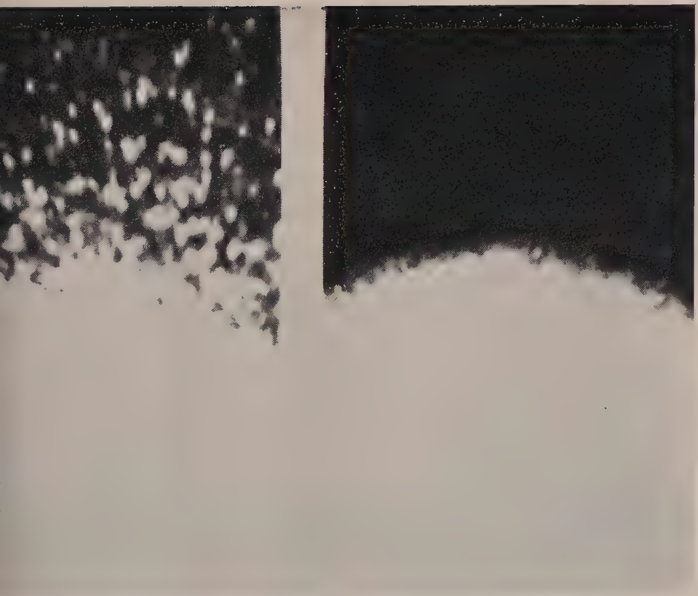


Fig. 17. Same record as in Fig. 16 having been selectively etched. (×3000)



g. 18. Examination under critical incidence of a record with ckground noise (left) and without background noise (right). (×30)

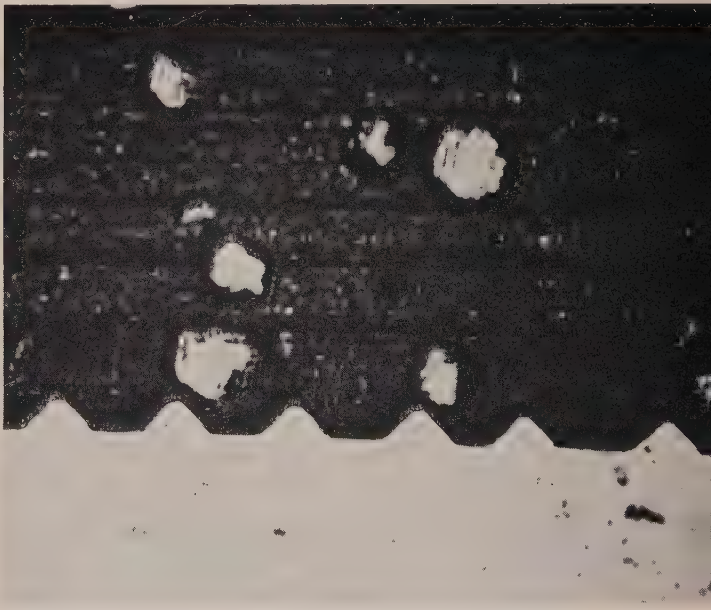


Fig. 19. Detection by microtomy of heterogeinity revealed by episcopic observation under critical incidence. The centre of the disc is to the left of the figure. (×150)

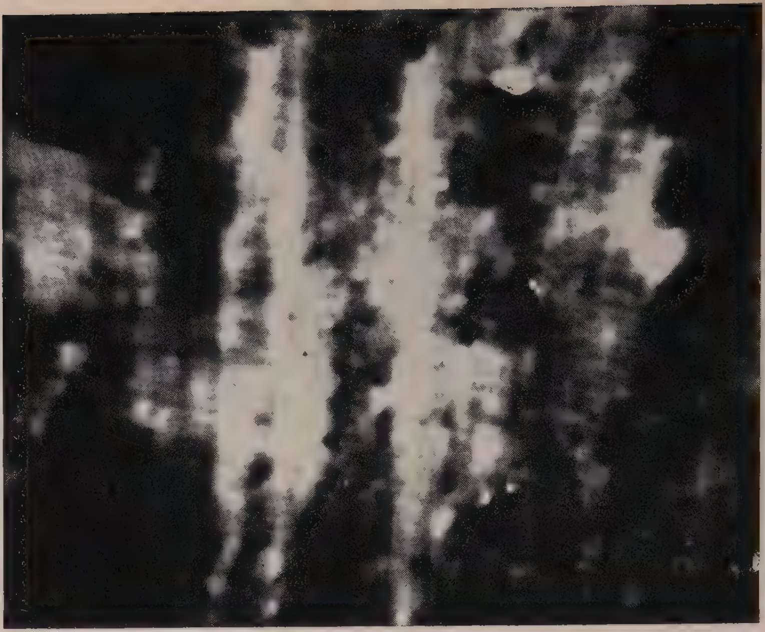


Fig. 20. Detection by ultra-microtomy of heterogeinity in a mixture of p.v.c. and methyl methacrylate. (×20000)

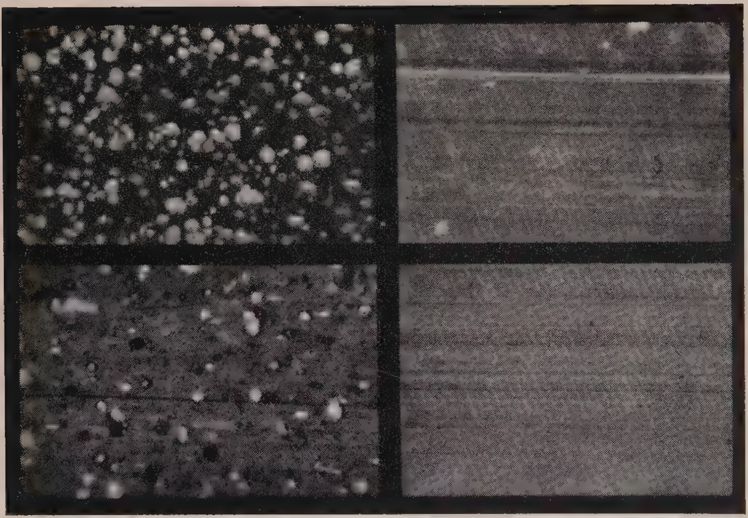


Fig. 21. Part of the control atlas for recording the homogeinity of compounds for discs. (×20)

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in circumstances where all other methods are inapplicable.

5. CONCLUSIONS

The micrographic study of microgrove records from various sources by a collection of microscopic techniques ranging from binocular examination to the highest possible electron-optical magnifications has allowed us to discover some fundamental causes of their background noise.

This type of investigation has, at the present time, become indispensable not only to ensure the quality of biscuits and granules, but also in a much more general way, to judge the nature and origin of all faults which may affect the quality of reproduction of a recording by using an unsatisfactory compound, quite apart from bad conditions of moulding or engraving.

These investigations constitute a very valuable instrument of research in the hands of the plastics development engineer responsible for the choice of new resins or compounds put forward by the chemist.

ACKNOWLEDGMENTS

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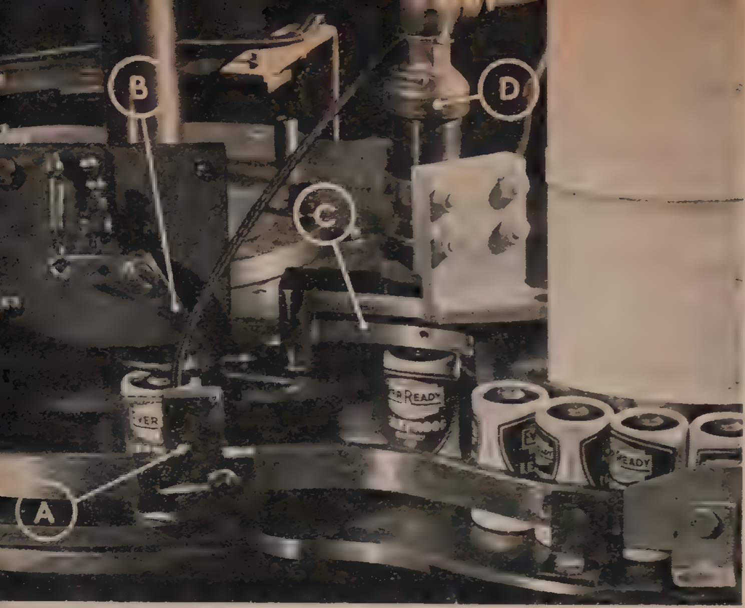

Fig. 1. Close-up of test station, showing the first Airmec detector coil (*A*) opposite the hanging contact (*B*) of the continuity test circuit, and the reject gate (C) in the open position, having been raised by the actuator (*D*).

BATTERY CELL TESTING

A new system of testing dry battery cells

THE EFFICIENCY of the dry battery cell depends on good electrical contact between its component parts, which in turn depends on the effectiveness of the manufacturing process. Each unit is therefore carefully tested for continuity under load before being passed for sale. To eliminate the bottleneck caused by manual testing, The Ever Ready Co. (Great Britain) Ltd. has developed an ingenious set-up for testing their "Leakproof" cells.

The equipment used is illustrated in the photographs, which show the test station at the end of one of the production lines. In Fig. 1 the cells are delivered from the left to the lightly spring-loaded hanging contact (*B*), which is swept by the positive electrode of each cell as it passes. The base plate of each cell is earthed to the machine. Cells which fail the continuity test are automatically rejected down a chute to which they are diverted by the opening of a gate (*C*). This is normally in the closed position to deflect the cells towards the packing station out of view at the right. The gate is raised by a pneumatic actuator (D) operated after an appropriate delay by the continuity test circuit.

Timing problem

When a faulty cell is detected, opening of the gate must be delayed until the faulty cell reaches it. The gate must then be closed before the next cell arrives. The operation is complicated by the fact that cells are offered to the testing station at a high but irregular rate. If the gate were directly controlled by the test circuit, a lot of spurious operation would inevitably result, since every vacant position on the feed mechanism would produce a "no continuity" signal.

At the high rate of operation involved, it was found that, with such direct control, the almost continuous chatter of the gate actuator led to out-of-phase errors and to jamming, which occurred when a cell arrived at the gate while the gate was closing. The obvious answer was to provide some means of detecting the actual presence of a cell at the testing station before validating the continuity test. The combination of speed and the light weight of the cells ruled out any such means as microswitches, which demand physical contact with the cells. Photoelectric scanners could not be used because of the limited space available and the high ambient light prevailing. After some consideration, a satisfactory solution was devised, based on the use of a detection system designed for quite another purpose. This application serves to illustrate the versatility of a highly sensitive system of detection which is becoming increasingly common.

Tool alarm unit

The basis of the system is the Type N 263 tool alarm unit made by Airmec Ltd. Intended originally for use on machine tools, it consists essentially of one or more detector coils, moulded in Araldite, connected to transistorized alarm units. The coils are intended to be placed around tools such as drills or reamers, which act as an inductive core. When a tool breaks, the inductance of the core is altered, and the detector circuit operates relays which can be used to stop the machine or to sound alarms. Up to twelve plug-in detector circuits can be operated from one power unit, so that multi-station machines can be monitored from one point.

In normal operation, the detector circuit will react to a breakage resulting in a reduction in tool length of as little as one diameter. Sensitivity is therefore more than adequate to detect the passage of a dry cell across the face of one of the coils, with complete certainty. The small size of the coils (less than one inch square and half an inch thick) permitted the type of installation seen in the photographs.

Three detectors

The whole timing sequence, from detecting the presence of a cell at the testing station to the closing of

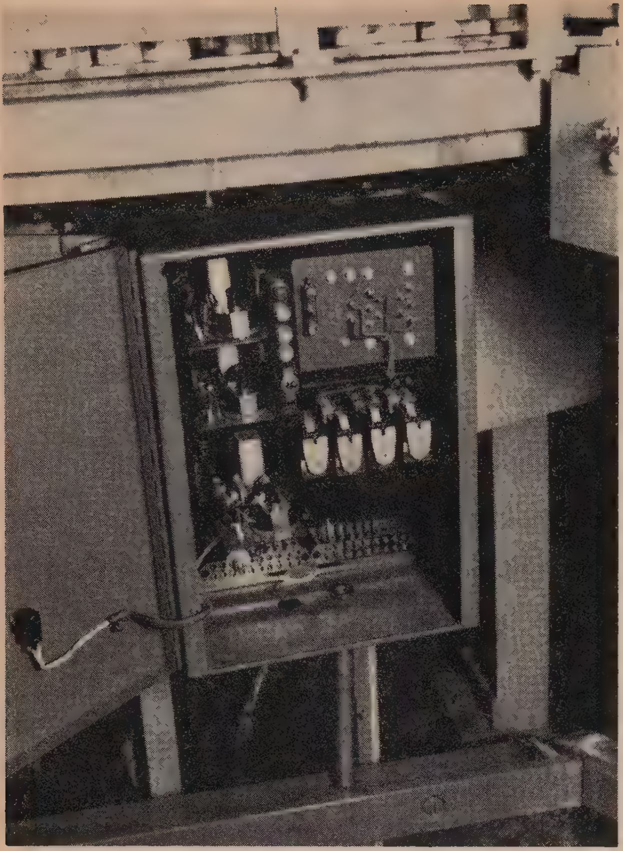

Fig. 2. Three Airmec detector chassis (left) operate in conjunction with Ever Ready's own memory unit (bottom right) to ensure that the reject gate opens and closes at exactly the right times.

the gate ready for the next cell, is controlled by three of these detector circuits, the chassis being mounted in a box under the machine, as shown in Fig. 2. The three chassis at the left are the Airmec alarm units, with their common power unit at the top right. The relays below the power unit form part of the memory circuit designed by Ever Ready to control the actual operation of the gate actuator.

The first detector coil is mounted directly in front of the continuity test station; it is shown at (*A*) in Fig. 1. Coincidence of the presence of a cell and a "no continuity" signal from the test circuit triggers the memory circuit which "holds" the signal until the appropriate moment for opening the gate. This moment is signalled by the second detector (*E*) in Fig. 3, which shows the rotary feeder from the rear. This coil detects the passage of steel pillars, each pillar corresponding to a cell station. The coil is so placed that, when a pillar and coil coincide, a rejected cell will have reached the ejection point, and the gate is opened. A third detector (*F*), at the right of Fig. 3, is two stations ahead of the second coil, and provides the signal for the closing of the gate, in time for the arrival of the next cell, should it be a sound one.

This system has been found to work perfectly in practice, and has proved to be the most economical method of dealing with the high throughput. The solution is typical of many which show that this inductive alarm system offers a combination of sensitivity, robustness, economy and lack of ambiguity which well repay ingenuity in application.

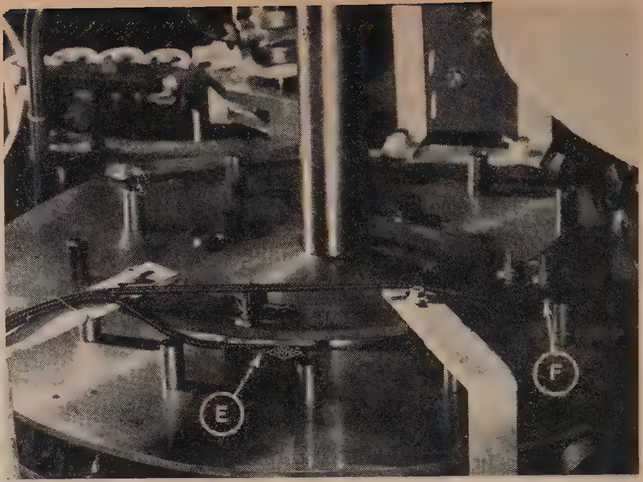

Fig. 3. The second detector coil (*E*) provides the signals for opening the reject gate after the arrival of a faulty cell, the third coil (*F*) for closing it before the next cell arrives.

Another recent adaptation, tried when all other methods had failed, concerned the prevention of jamming on an automatic press in which the copious supply of lubricants precluded the use of photoelectric detectors, and vibration was too severe to accommodate any moving parts such as switches. Special detector coils were made up to detect the passage of very small pressings from the press tools. The control circuit was set to operate if a component did not reach the detector, indicating jamming in the tool, or if it remained within the coil for too long, suggesting a pile-up further down. This installation in very short time repaid its cost in the saving in broken tools and production downtime.

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SUBMISSION OF ARTICLES

Technical articles will be gladly considered for publication, payment being made by arrangement. Articles should preferably be from 3,000 to 4,000 words, but no rigid limit is imposed. Manuscripts should be typewritten, in double spacing, on one side of the paper only. Diagrams may be drawn in pencil provided that they are clear and adequately lettered. For half-tone illustrations, glossy prints are preferable. While every care is taken of MSS. submitted, no responsibility can be accepted in case of loss.

SWEDISH COMPONENTS SHOW

THE Fourth Stockholm Exhibition of Radio and Electronic Components, Instruments and Gramophone Equipment, organized by the Radio and Electronic Component Manufacturers Federation was held in Ostermans Marmorhallor, Birger Jarlsgatan 18, Stockholm, Sweden during the period 9th October to 13th October 1961. The show was opened by the British Ambassador to Sweden and was the largest and most comprehensive yet organized by the R.E.C.M.F. abroad.

The products on Stand No. 30 included those of **Associated Electrical Industries Ltd.**, Electronic Components Division and **Thorn A.E.I. Radio Valves and Tubes Ltd.** The former had industrial valves, cathode-ray tubes, A.E.I. Clix radio and electronic components, test equipment and p.t.f.e. components on show. The latter displayed a wide range of high performance television receiver valves of frame grid construction—among them being what is claimed to be the world's first variable-mu high performance frequency changer—and new 19 in. and 23 in. cathode-ray tubes.

Industrial valves included tetrodes for series or shunt regulation in d.c. control systems, double tetrodes for operation as push-pull amplifiers or frequency treblers up to 600 Mc/s in low and medium power transmitters, grid-controlled rectifiers with applications in welding control equipment, and valves for power rectification and communications purposes.

Cathode-ray tubes included types for television programme monitoring, for radar display equipment, and for data display applications.

P.T.F.E. was exhibited in the form of moulded components, dispersion coating, rod, tube, sheet and tape.

Notable among a range of A.E.I. Clix Components were the Minitrim, a miniature screwdriver-set potentiometer only 0·4 in. square by 0·8 in. long, and a new printed-circuit connector.

The A.E.I. transistor tester Type R2446 was also displayed. This is a simple inexpensive portable unit which gives direct measurement of short-circuit current gain and collector leakage current of both *n-p-n* and *p-n-p* transistors in common emitter connection.

Frame grid valves. The Ediswan 30C17 (PCF87), one of three new types for television tuners by **Thorn-A.E.I.,** is claimed to be the only frequency changer in the world which can be operated in a television tuner to provide high conversion gain with good stability and at the same time be gain-controlled by at least 100:1 from the a.g.c. line. Application of gain control to the frequency changer stage enables improvements to be made in the a.g.c. and cross-modulation performance of the whole receiver. If the gain of the two tuner valves only is controlled, a straight first i.f. amplifier can be used with consequent higher i.f. gain resulting from the higher-slope valve.

With the 30C17, the gain of the frequency changer stage can be controlled by at least 40dB, with a change in the tuner response curve of less than 2dB and negligible oscillator shift.

Another exhibit, the 30L17 (PCC806), was a high-performance frame-grid cascode r.f. amplifier, designed to provide the highest possible gain as a double-triode cascode amplifier with extremely stable operation. The frame grid construction results in a mutual conductance of 18·3 mA/V at an anode current of 15·8 mA, and careful internal screening ensures that the extra gain can be employed without the risk of instability. A low noise factor can be obtained, while the variable-mu characteristics provide good gain control with minimum cross-modulation, and without the need for a high level of a.g.c. voltage.

For tuners where the full performance of the 30L17 is not essential, the 30F27 (PE801), a high-gain low-noise all frame-grid variable-mu tetrode economically combines high gain and large signal handling ability with ease of operation. It has a mutual conductance of 15mA/V at an anode current of 13·5mA and screen current of 1·7mA. This tetrode used in the stage of a television tuner offers certain advantages over the more conventional double-triode cascode arrangement—the number of components is reduced, layout is simpler, and for valves having comparable slopes the single cathode-type valve is a more economical unit.

The 6F29 (EF183) and the 6F30 (EF184) are high slope pentodes, intended for the i.f. stages of television receivers; the former with variable-mu characteristics for gain-controlled stages.

The 6F28 (EE80) and the 30FL12 (PCE82) are high-slope beam tetrodes with identical characteristics primarily designed for video amplifier applications with the present British 405-line system. The 30FL12 also incorporates a general-purpose triode. The high available peak current and slope of these valves enable ample video drive to be provided for the cathode-ray tube with anode loads as low as 4,700Ω (even allowing for the changes in characteristics during life), thus easing h.f. compensation problems while still giving increased sensitivity. These valves may be used in dual-standard television circuits where a minimum anode load of 4,700Ω is acceptable and the dissipation ratings will not be exceeded.

The 30FL13 (PCE80) tetrode enables receivers to operate satisfactorily at appreciably lower video signal levels than with previously available sync. separator valves. When maximum sensitivity is required single limiting operating conditions can be employed, but the greatest immunity from noise is achieved by double limiting operation.

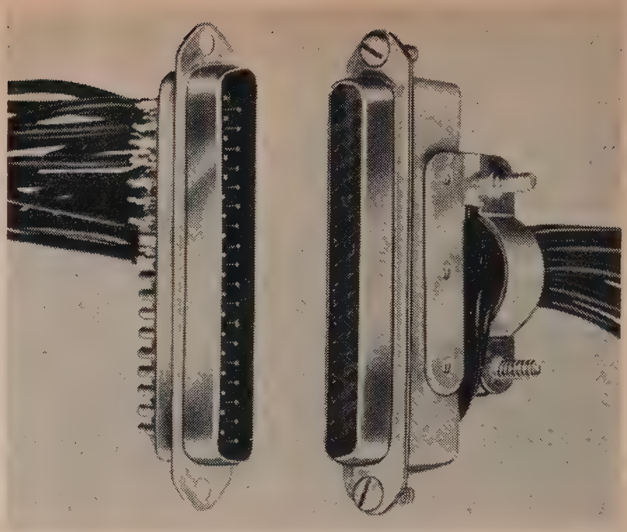
New cathode-ray tubes. The CME1903 is a 19in. tube with magnetic deflection and a unipotential electrostatic focus gun. The heater voltage is 6·3V at a current of 0·3A for television receivers with 0·3A series-connected heater chains. The diagonal deflection angle is 110° and the gun has been designed to provide high beam currents without defocusing. A reduction of neck length to 107mm. from the more usual 130mm. has been achieved with only a small increase in deflection power and without appreciable deterioration of focus uniformity. The overall length is 300mm. and the final anode design centre rating is 17kV.

The CME1904 is basically a CME1903 with an integral implosion guard of tinted plastic to give an overall light transmission of approximately 50% at the centre and with an overall length of 305mm. The CME2303 is a 23in. cathode-ray tube with magnetic deflection and a unipotential electrostatic focus gun. It has a 6·3V 0·3A heater for use in 0·3A series-connected heater chains. The diagonal deflection angle is 110° and the gun has been designed to provide high beam currents without defocusing. A reduction of neck length to 110mm. from the more usual 130mm. has been achieved with only a small increase in deflection power and without appreciable deterioration of focus uniformity. The overall length is 358mm. and the final anode design centre rating is 17kV.

The CME2306 is similar to the CME2303 and fitted with an integral implosion guard of tinted glass. It has an overall length of 366mm.

The V3260 is an aluminized 14in. rectangular faced cathode-ray tube having magnetic deflection and a unipotential electrostatic focus gun which has been developed for use in transistorized television receivers. The diagonal deflection angle is 90° whilst the maximum neck diameter is 29·4mm. The heater requires 12·6V at 0·3A, and the final anode design centre rating is 16kV.

In addition to the valves and tubes featured above, **Thorn-A.E.I.** showed a range of valves for television receiver deflection circuits, and preferred ranges of valves for a.c. only and for a.c./d.c. a.m./f.m. radio receivers. This comprehensive range of valve and tube types, it is claimed, demonstrates the new Company's leading position as a supplier to the radio and television entertainment equipment industry. These valves and tubes are marketed in Britain under the Mazda trade mark and overseas under the Ediswan trade mark.



Amphenol-Borg connectors.

The Amphenol Electronics Division of **Amphenol-Borg Ltd.,** exhibited many new connectors including the Series 48 Connectors to MIL-C-26500: these are miniaturized high-temperature connectors specially designed for military use having crimpable contacts and are supplied in a number of shell sizes and contact arrangements. Connectors for printed circuits, and rack and panel applications, cables with both teflon and polythene dielectrics and "Microdials", "Micropots" instrument motors and a range of coaxial switches were also shown.

Phenolic plastics materials, among the earliest products of **Bakelite Ltd.,** are still some of the most important plastics exported. They were, therefore, featured prominently among the exhibits on this Company's stand.

A comprehensive selection of mouldings illustrated the varied applications of Bakelite phenolic moulding materials, and alkyd and Vybak (p.v.c.) moulding materials were also featured. Vybak is also used for the insulation of electric cables, and a wide range of cables were displayed.

A telephone hand-set incorporating printed circuits produced from copper clad Bakelite Laminated was among the range of exhibits which use this material. Other examples include an f.m. radio tuner, a television receiver, transistor radio and computer assembly.

Paper and fabric based Bakelite Laminated are extensively used by the radio and electronic industry, and among the examples shown was an instrument case, a neon panel for an electronic calculator and a computer block board panel assembled with contacts.

Beckman Instruments Ltd., displayed a complete range of Helipot precision potentiometers and Duodial turns-counting dials. Centre piece of the stand was an outsize cut-away model of a Helipot Model A precision potentiometer. Measuring over two feet high, this model revealed the inner workings of a product in which the Company have specialized since 1940.

Adjacent to the cut-away model were normal-scale examples of special potentiometers made to customers' requirements. These included versions with multiple taps and gangs, front and rear extension shafts and coloured transparent cut-aways. Parts making up a Helipot Model A potentiometer were shown on an illuminated display board.

The **Belling and Lee Ltd.,** exhibits comprised a comprehensive selection from their extensive range of plugs and sockets (single, multi-way, screened and unscreened), terminals and terminal blocks, fuseholders and fuse-links, thermal switches for current overload protection and time delay processes, interference suppressors, as well as television aerial accessories, and a number of set-top aerials.

Among the items which were of special interest to Scandinavian visitors, was a new range of fuse-links, size 0, for the protection of semiconductor rectifiers. Because of their low internal resistance, and their small physical size and consequent low thermal capacity, these rectifiers are easily damaged by overloads, and to protect them a really fast acting protecting device is required. Another new item was the "Continental" range of terminals, so called because of their up-to-date styling and the fact that they are provided with a socket in the top which accepts the standard 4mm. wander plugs extensively used by European equipment manufacturers. These are competitively priced. There was also a new style of flexible terminal block, in which flexibility is considerably increased without any sacrifice of mounting security or performance characteristics.

On the aerial side, Belling and Lee Ltd. showed examples of their set-top aerials including the well-known Golden V, and the new Monitor which was successfully launched at the Radio Show. Also in evidence was a new portable aerial for use in motor cars etc., and a full range of outlet boxes, diplexers, and triplexers for use on v.h.f./f.m. and television installations.

Eight new lines were added to the extensive range of products exhibited by **A. F. Bulgin and Co. Ltd.,** and these included transparent instrument knobs with the internal legend dial visible through the shock-resisting plastic; collet fixing knobs which are vibration resisting and have the collet tightening screw hidden under a clip-in moulded bung; a neon glow fuse holder in which the lamp glows when the fuse blows thus enabling instant location and replacement; an illuminated panel mounting cursor indicator which provides ×2 magnification and has two cursor lines to avoid parallax error. Also shown were various types of micro switches and mains operation toggle switches.

To emphasize the extent of their range, the **Cannon Electric Co. Ltd.** displayed one of the largest of their MS range of multi-contact connectors compared with the latest Micro-D series which is the Company's latest contribution to microminiaturization and has a contact density of up to 420/in^2. Among the many other items on show were a series of solenoids, sub-miniature terminals and audio connectors.

"Cyldon" trimmer capacitors and tuner units were shown by **Sydney S. Bird and Sons Ltd.** The tuner units included types for separate a.m. and u.h.f./f.m. circuits and units for use in combined a.m./f.m. receivers. Other units exhibited were a push-button television tuner and a variable u.h.f. television tuner.

Wirewound potentiometers were featured by **Colvern Ltd.** and, besides standard types, the Company also displayed sealed tropical, helical, high-accuracy precision, synchro and cam corrected units.

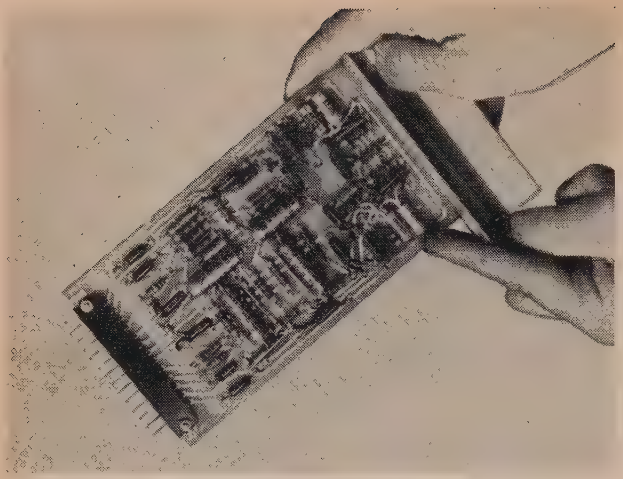
Several of the new components which were a feature of the **Electronic Components'** stand at the R.E.C.M.F. Exhibition at Olympia were again on display at Stockholm. These included a 16 make/break single or double pole switch available in up to six banks; an edgewise or front panel switch needing only a change in the mounting plate to provide either facilities; and a range of printed-circuit edge connectors. The Elcon electronic fader and the four-channel mixer designed to provide "professional" performance in the "enthusiast" price range and midget r.f. chokes, Minitor plugs and sockets and fibre glass resistors were also displayed.

Electrolube is an electrical and mechanical lubricant which, the manufacturers **Electrolube Ltd.** claim, offers an entirely new approach to problems of both electrical and mechanical wear. It has the property of loosening and preventing the formation of tarnish and corrosion by a mechanical action due, partly to its molecular structure. It prevents arcing, tracking, contact burn and mechanical wear on any contact or bearing surface—including wood—over a temperature range of −46°C to +245°C.

As component suppliers to transformer and choke manufacturers and also manufacturers of complete transformers and chokes for all types of electronic apparatus, the **English Electric Co. Ltd.,** have supplied to Swedish manufacturers a large volume of aircraft, communications and electronic equipment. The Transformer Department of the Company exhibited a range of "C" type cores for single-phase transformers and chokes and "E" cores for three-phase working, together with their accessories; a range of single-phase "C" core hermetically-sealed, dry-type and resin-cast transformers and chokes and three-phase dry-type "E" core transformers; and a range of current transformers, which incorporate toroidal cores.

The Meter, Relay & Instrument Division of the Company showed a selection of miniature, moving-iron and moving-coil instruments together with a representative selection of special instruments mounted in miniature cases. The display included ammeters and voltmeters, in the various case sizes that are available in the miniature range.

The miniaturization of components has required the development of new soldering techniques and **Enthoven Solders Ltd.** displayed a wide variety of solder washers and preforms—both solid and flux impregnated—designed for this purpose. Two million of these components were supplied to the U.S.A. for use in the control devices of the "Echo" satellite.



Printed-circuit panels on Formica DCC20 copper-clad material.

Another space age connection is claimed by **Formica Ltd.** who supplied industrial laminates as a base material in the Colvern potentiometers for use in tracking the flight of Commander Sheppard's space rocket. The Formica stand laid special emphasis on copper-clad material used for printed circuits, but printed and engraving material used extensively in the manufacture of mimic diagrams and instrument panels was also featured.

The miniature loudspeakers manufactured by **Goodmans Industries Ltd.,** for use in portable and transistor sets had their first foreign showing at Stockholm. These speakers can be supplied in various magnet strengths in 2 in., 2¼ in. and 3 in. sizes. Other equipment shown included high-fidelity loudspeakers up to 15 in., including several new models, and a range of vibration generators with associated driving equipment.

Four divisions—Plastics, Terminals, Cable Accessories and Connectors—of **Hellerman Ltd.,** showed a wide range of the Company's products. Plastic mouldings were displayed in a wide variety of thermoplastic and thermosetting materials and extrusions in a number of thermoplastic materials as was Helazipp the new cable binding material which is a flexible p.v.c. tape with interlocking beadings along each edge. Solderless cable termination equipment and terminal blocks; a wide range of wire strippers, sleeving tools and cutters and samples from the range of connectors were also shown.

Hughes International (U.K.) Ltd., who were exhibiting for the first time at Stockholm, showed high-grade subminiature diodes and rectifiers in hermetically-sealed glass encapsulation; microminiature transistors of 0·062 in. diam., and 0·030 in. thick; and double diffused mesa transistors. The Hughes International (U.K.) Ltd. voltage variable capacitor was featured in a working exhibit showing its application in a radio tuner unit tuned to the Stockholm v.h.f./f.m. service and in the modulation circuit of a f.m. signal generator

Among the miniature and standard capacitors shown by **A. H. Hunt (Capacitors) Ltd.** were dry electrolytic, metallized paper, metallized film, metallized paper and film, foil and paper, silvered mica and stacked mica, ceramic and printed-circuit types.

Under the trade name Lemco the **London Electrical Manufacturing Co. Ltd.,** showed their full range of silvered mica, silvered ceramic and polystyrene capacitors together with specialized types for use in printed circuits. The Company also displayed electronic testing equipment for voltage proof testing of capacitors.

Linton and Hurst Ltd. exhibited a range of electrical steel stampings, including miniature laminations. Silicon iron, grain orientated and nickel iron alloy stampings were on view together with a range of toroidal cores.

A selection of industrial valves and cathode-ray tubes representative of the wide range marketed by the **M-O Valve Company Ltd.** were displayed. These have wide applications in the fields of communications, radar, industrial electronics and oscillography.

The latest addition to the range of periodically focused travelling-wave tubes, the TWC5, was included in the display of microwave products. This is a travelling-wave tube power amplifier capable of delivering 10W in the 5·8 to 8·2kMc/s band and has been specially designed for use in high-quality multi-channel telecommunication and television relay systems. A key feature is its plug-in replaceability with minimum adjustment which is considered to be a notable advance over comparable types.

The TWS10 was one of the range of S-band tubes shown. This can give a minimum saturated power of 18W and a minimum low gain level of 30dB in the 1700 to 2300 Mc/s band. Although specified and measured over this band, the tube performs satisfactorily up to 4000 Mc/s.

A magnetron particularly useful for marine radar in overcoming interference problems was on view. This forced air cooled X-band tunable non-packaged pulse magnetron, Type MAG9, has an indirectly heated oxide cathode. The tuning system is intended for pre-setting to a frequency of ±75Mc/s within the range 8900—9600 Mc/s. Because of its limited tuning range, the price of this valve is lower than conventional tuned magnetrons. Another X-band magnetron shown was the 2J51A. This is a forced air-cooled packaged magnetron, tunable within the range 8500—9600Mc/s. The maximum power output is 50kW.

Two types of backward wave oscillator were shown—the BWS1 and the BWX3. The X-band valve is designed to give more than 100W c.w. between 8500—10400Mc/s. It is a boxed valve supplied complete with permanent magnet to form a robust compact unit, and is capable of withstanding an impact of 50G and a continuous acceleration of 20G. This valve features good drift characteristics. The total frequency drift is of the order of 30Mc/s after the 3 min. warm-up period.

Among the transmitting valves on view was the ACS5, a fully concentric ceramic air-cooled tetrode designed for use in linear power amplifiers for both audio-frequency and radio-frequency, and capable of delivering 17·5kW with zero driving power. Also on show was the DET29, a disc seal microwave triode, primarily for use as an oscillator up to 4000 Mc/s and an amplifier or frequency multiplier up to 7000 Mc/s. This valve is especially suitable for telemetry applications.

A hydrogen-filled grid-controlled gas-discharge modulator Type GHT4 was representative of the gas-filled valves shown. This valve features a hydrogen replenisher system containing a large volume of gas, which is controlled by a barretter and thermistor and gives a sensibly constant gas pressure with wide variations of supply voltage and ambient temperature. In this respect the valve's characteristics remain substantially constant until end of life. The maximum rating is 25kV.

A new 5 in. (12·7cm) instrument cathode-ray tube, Type LD603, with high efficiency post deflection acceleration giving high deflection sensitivity was displayed. This tube features a new form of p.d.a. which produces three times the deflection sensitivity of normal helical p.d.a. tubes while maintaining a similar scanned area of 10×6cm.

The 900F is one of two new double-gun high sensitivity tubes with helical p.d.a. shown. It has a 3·5in. (8·9cm) screen, and under typical operating conditions of $4\mathrm{kV}_{a4}$ and $1{\cdot}2\mathrm{kV}_{a1,a3}$ has a deflection sensitivity in the y direction of 17·5V/cm and in the x direction of 30V/cm. Each gun can scan a 6cm square, with a common "window" of 6cm×4·8cm.

Examples from their range of plugs and sockets, valveholders and precision wire wound resistors were shown by the **McMurdo Instrument Co. Ltd.**

Morganite Resistors Ltd. displayed their full range of fixed and variable carbon composition resistors, ceramic resistors, non-linear voltage dependent resistors, ultra high ohmic resistors and power waveguide attenuators. Of three types of sealed control shown, the Type 4 has just been uprated to Humidity Category H1 in accordance with Specification DEF.5122. A selection of Termilode waveguide loads were shown, made from a new material of silicon carbide type, which functions satisfactorily in the range up to 1000°C.

Multicore Solders Ltd., demonstrated an automatic soldering machine incorporating twin soldering heads each with its own solder wire supply and automatically making soldered joints on mild steel strip. One of the heads was supplied with a single rosin-cored solder wire whilst the other was fed with Ersin multicore Savbit alloy containing extra fast Type 366 Ersin flux. It is claimed that this test provided conclusive proof of the efficiency of Savbit alloy and at the close of the exhibition showed how little soldering iron bit wear had taken place in the head using the Savbit alloy. This alloy prolongs the life of bits by 10 times and is now used by many of the leading electronic manufacturers throughout the world as a means of obtaining better soldering with reduced costs. The introduction of a small percentage of copper into the alloy prevents the absorption of copper from the soldering bit, thus eliminating the need to frequently resurface and maintain soldering irons.

New tin/lead/silver alloys and specially low and high melting point solders in addition to a wide range of standard tin/lead alloys incorporating three or five cores of non-corrosive Ersin flux were also shown.

A special section of the exhibit was devoted to package lines of Ersin multicore solder which are available for distribution at home and overseas. In addition to the solder products, Multicore also exhibited the Bib range of accessories, including wire strippers, tape splicers, tape reel labels and the bib tape accessory kit.

N.S.F. Ltd., exhibited switches of the rotary wafer type for circuit and band selection and general tap switch applications; lever switches meeting electronic and aircraft instrument requirements; rotary solenoids and circuit selectors; sub-miniature hermetically-sealed relays, and carbon-track potentiomers.

The Oak range of multi-bank rotary wafer switches caters for normal and heavy duties. Included is a 1 in. diam. pattern known as the Model "A", designed for restricted spaces. This switch provides up to 12 positions per wafer and has a continuous rating of 2A. In the same range are offered switches with push button and slide knob operation and wafer type lever switches—the latter meeting requirements where restricted space precludes use of the normal type rotary wafer switches.

The Cutler-Hammer range of lever-operated electronic and instrument switches caters for 3—20A circuits and offers various actions and connection arrangements. Recent additions to this range, known as Rockette switches, include moulded operating rockers in a variety of shapes, sizes and colours.

Ledex rotary solenoids make use of inclined ball races to convert linear movement to rotary movement. The work to rotation curve is substantially even and the solenoids provide high torque for size, and a snap action and dependable rotary movement for angular rotations up to 95°. Ledex circuit selectors use the predetermined angle of rotation of the solenoids in conjunction with rotary wafer type switches. The field of application includes stepping, counting, adding and subtracting mechanisms.

N.S.F.-Union relays are sub-miniature 6-pole changeover relays suitable for operating over a temperature range of $-65°$C. to $+125°$C. Voltages of available operating coils vary between 6—120 V d.c.

The display of **Painton and Co. Ltd.** included production models of a new edge connector for printed circuits. Two methods of termination were shown i.e. solder tags and printed-circuit pins. The range is produced in a moulding material of great mechanical strength and with excellent electrical characteristics and the socket clip design ensures a good contact with the minimum of wear on the foil. The largest size displayed was the 32-way type, and models were shown with board guides and with open ends to take a board with a width greater than the length of the connector. This series had already been discussed in Sweden between engineers in the industry and representatives of the Painton associate company Svenska Painton. This was the first time, however, that actual models had been shown in Sweden and these caused considerable interest.

A new range of miniature plugs and sockets was also shown. This range employs a flat plug blade similar to the larger Multicon range and has been designed to provide the reliability associated with that range. Recent additions to the Company's toggle switch, push-button switch and spring terminal ranges were also shown together with the latest version of a miniature rotary attenuator. A special display of the Northampton produced Painton Bourns Trimpot miniature potentiometer was mounted which included a sectioned model of the Type 224.

PAINTON & COMPANY LTD.

A view of the Painton stand at Stockholm.

Printed-circuit quadrant faders as used in television studios in this country were displayed showing some of the variations obtainable i.e. illuminated dials, precueing, ganged controls and self-returning arms.

Various samples of wire-wound resistors, high-stability carbon resistors and r.f. chokes were shown together with potentiometers, rotary stud switches and moulded knobs.

The transformers exhibited by **Parmeko Ltd.,** were representative of types ranging from miniature transformers for transistor circuit applications to those rated up to 5kVA, 50c/s. embracing resin-cast oil-filled and air-cooled constructions. Transformers for high-temperature working applications and those meeting relevant Services specifications were also displayed. Particular emphasis was given to their Saturn Series transductor range and working exhibits of magnetic amplifier applications were on show.

Plessey International Ltd., exhibited many examples from its wide range of electronic products, including components and devices for use in professional equipment, aircraft and missiles as well as those for the domestic and entertainment radio and television field. A feature of the display was the emphasis placed on high quality components conforming to the stringent requirements of the British Armed Services.

Items on view comprised the latest additions to the range of Castanet tantalum capacitors; new stacked ceramic capacitors, and ranges of connectors including the recently introduced UK-AN type.

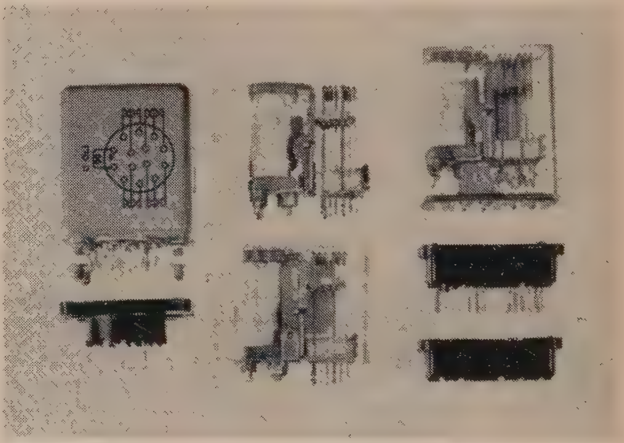
The Company's activities in the field of semiconductor devices were represented by a wide range of silicon rectifiers and by MADT transistors for high-speed switching applications.

Among examples of loudspeaker production using newly developed techniques was a unit of only 55mm. diam. for pocket radios, and the capacitors on view included variable, polystyrene and electrolytic types—in the last named range a new miniature plastic cased version has recently been introduced.

Of interest to the computer industry were examples of square loop ferrites available either as cores or completely wired and assembled in the form of a memory store. Alternatively, Plessey is able to offer complete computer systems together with core drivers and associated power supplies.

Miniature relays for operation over a wide range of temperatures were shown in both sealed and unsealed versions, while the moulded track potentiometers on view comprised many Type Approved units.

Examples from the wide range of synchro and servo components, radar absorbing material, moulded fibre products for the electronic engineering industry and examples of products in the nucleonic and telecommunication fields completed the Plessey display.



Hermetically-sealed, open and protected versions of Plessey miniature relays.

Rola Clestion Ltd. showed a wide range of domestic type loudspeakers ranging from 2 in. to 12 in. diameter and included many oval loudspeakers. The Company also exhibited a range of industrial loudspeakers designed for use under arduous conditions such as those experienced in railways, aircraft, shipping, mines, mobile units and factory installations.

Twelve different groups of components were displayed by **Standard Telephones and Cables Ltd.** and included transistors; tunnel devices; signal diodes; thermistors; hermetic seals; selenium rectifiers; silicon rectifiers; infra-red optical filters; valves; quartz crystal devices; capacitors and magnetic materials. Featured by this Company were a working power oscillator demonstrating the use of silicon double-diffused transistors, and a working adding and multiplying machine showing some of the circuit applications of tunnel diodes. Three recent additions to the S.T.C. range of selenium rectifiers—the RS600 series of 23A rectifiers; the RS200 series, an improvement on the RS2 500 mA rectifiers; and the Z5A series 7·5 W zener diodes for voltage reference were also shown.

Steatite and Porcelain Products Ltd. exhibited a variety of ceramic products for electronic and electrical equipment. High-quality pressings in frequentite; nickel-metalized terminal seals; extruded rods, tubes and coil formers; Steatite porcelain die-pressed parts; high grade Vulcanex refractory material, and Faradex and Tempradex ceramic dielectric materials for ceramic capacitors were among the components displayed by this Company.

The Special Products Division of **Thorn Electrical Industries Ltd.** showed mainly indicating and control devices used in aircraft and electronic applications. Electroluminescent lamps made in a variety of shapes, with negligible current consumption, were demonstrated in an electric clock with an electroluminescent dial which glowed softly but clearly in the dark, an illuminated telephone dial, and an illuminated wall-switch surround. A representative range of electrical connectors was shown, including MS and Pygmy standard and solderless types, and included new developments in the series. In the midget indicator components section, the recently introduced twin filament warning indicator was shown. The lamp continues to function even if one filament fails and gives self-evident warning of the need for lamp replacement. A comprehensive range of relays was shown and a noteworthy inclusion in this department was the T100 sealed double-pole make/break unit for use in aircraft electrical systems. Other components included the Plasteck panel lighting featuring a new method of photo-etching the characters onto the panels and the use of printed wiring for the panel lighting circuit; bridge lampholders; multi-socket indicator strip; and a new range of built-in disposable signal lamps which have simplicity of installation as a principal feature.

Articles Provisionally Scheduled to Appear in Future Issues of this Journal

Component Measurements.

Transformers in the Electronics Industry (Part 3).

The Silicon-controlled Rectifier.

Fusing.

Use of Glass Fibre in Electronic Components.

Retainers and Fasteners.

Recording Heads.

Thermofit Caps.

Ceramic Sub-micro Disc Trimmer.

Glow-discharge Tubes (Parts 1, 2 and 3).

What to Look for in the Design of Holding and Switching Components.

Research on Insulation in Relation to the Reliability of Components.

Modern Methods of Circuit Protection and Control.

A Crystal Delay Line.

The Three-port Circulator.

Wiring of Printed-circuit Boards.

"Flowed-in" Gasket Process for Industrial Components.

Glass Applications in Transistors.

Termilode Waveguide Loads.

Survey of Wound Cores.

Printed Circuit Soldering Line.

Design and Testing of Electronic Circuits.

Ceramic Components.

Cold-cathode Thyratron for High Current Control.

Fans for Electronic Cooling.

Applications of Permanent Magnets.

Surveys of Valves.

Constant-voltage Transformers.

High-power Spark Gaps.

Mercury Gas Thyratrons.

Manufacture of Miniature Diodes.

Chemical Etching of Silicon.

Avalanche Transistors.

Trigger Circuits for S.C.R's.

Examination of Spike and Flat Leakage in TR Cells.

The list does not include the regular features, i.e., New Components, Activities in the Industry, Manufacturers' Publications and Personalities. Other additions will be reports on Conferences and Exhibitions, together with news features, articles and items of topical interest.

Correspondence

Some aspects of component reliability data

I should like to take this opportunity of commenting on the letter published in your October issue by Mr. I. F. M. Walker, on the subject of component reliability data.

Mr. Walker is quite correct in his interpretation of reliability data on components, and I think all those who are working in this field will agree that a great deal of data is published which is almost meaningless unless actual environmental conditions are specified. However, one must bear in mind the fact that this is a phase through which the electronics engineer must pass. A few years ago little or no information at all was available on failure rates of electronic components. In these circumstances, any information was felt to be better than none, and for this reason, data was collected by many workers in order to act as a guide to equipment designers.

It is probably relevant if I quote from a book written by myself and a colleague on this subject,* as follows:

"There are many difficulties in analysing failure rates in equipments, particularly in the Service field. Any accurate analysis requires three things to be known—

1. The total number of equipments, and of components in all equipments.
2. The time in operation.
3. The environment in which equipments are used or tested.

"Unless, therefore, *all* equipments can be tested to the *same* test conditions, it is not possible to present scientific, accurate data. Many factors contribute to the difficulties of accurate analysis: the date of manufacture of the components used in the equipment, which may sometimes be many years old; the circuit parameters, which may be almost in an unstable condition due to poor design; overloading of the components; poor or faulty maintenance, and so on. All these factors contribute to the difficulty of obtaining an accurate analysis. Recognizing this, therefore, the only way of tackling the problem is to build up experience and analytical data on certain equipments under given conditions."

I must point out to Mr. Walker that there are many difficulties in the way of publishing accurate information on failure rates of individual components under given environmental conditions, because these must necessarily be tied to a given component manufacturer. A few manufacturers are able—and indeed willing—to publish failure rates on their components, but many other manufacturers are not yet prepared to do the same.

Mr. Walker gives some interesting comparisons between quoted minimum and maximum failure rates and this, of course, only emphasises the fact that conditions of test are all important. It is, unfortunately, not possible to standardize these conditions for purposes of comparison, as the users' requirements vary so widely. One can instance the 20 years life required of the under-sea cable repeater amplifier component, which, after its initial rough handling on laying the cable, remains in static conditions free of vibration and shock and isolated from temperature and humidity variations. At the other extreme, one has components fitted in missiles which are subjected to their own individual series of shocks, vibration, temperature extremes, storage periods, etc. This is a problem which has occupied the minds of many people working in this field, and the only compromise which seems to be possible is to measure the failure rates of components at room temperature with humidity present in the United Kingdom (although this will, of course, vary), quoting the result in percentage per thousand hours. Again, as has been pointed out by other workers, this percentage is for the *first* thousand hours and continuous testing over ten, fifteen and twenty thousand hours may be necessary to obtain a genuine picture of failure rates, particularly for computers which have to operate for periods of many years.

I think the points raised by Mr. Walker on this subject are extremely opportune and this correspondence may help to clear away some general misunderstandings on failure rate data, which will be helpful to all those concerned in the use of electronic components.

G. W. A. Dummer,
M.B.E., M.I.E.E., Sen. Mem. I.R.E., M.Brit.I.R.E.

Poolbrook,
Great Malvern,
Worcestershire.

The letter from Mr. I. F. M. Walker published in your October issue raises matters of very great importance to the electronic engineer.

This Company is concerned primarily with the manufacture of resistors, and the conflicting statements concerning the reliability of such components is naturally a matter of considerable interest to us. It is possible that the apparent conflict to which Mr. Walker draws attention may be explained by the fact that different authorities have used different test conditions and have

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* *Electronic Equipment Reliability* by Dummer & Griffin (Pitman).

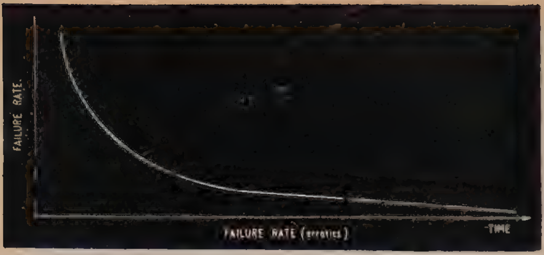

Fig. 1. Failure rate due to erratics with time.

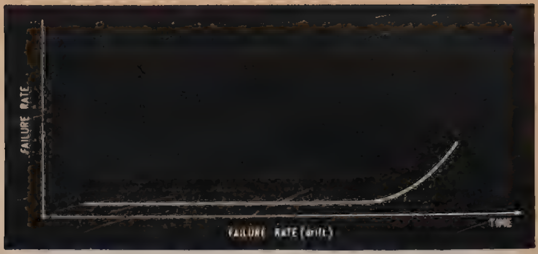

Fig. 2. Failure rate due to drift beyond some arbitrary limit.

chosen different types and values of resistor for their work. As a result, statements that are made concerning the reliability of resistors may all be correct but appear to conflict because the basis of the measurements is different. Apart from the above possibilities there are two other considerations to which we would like to draw attention.

In most types of resistor, especially those made from thin films or wires, there is a range of resistance value over which the component is very reliable. Nevertheless, when very thin films or very fine wires are employed, the components are of lower reliability. As a result it is not possible to give a comprehensive figure for reliability for any of these products which is not immediately misleading. If the figure is to take into account the highest resistance values, then it is bound to be too pessimistic about the lower values. On the other hand, if the figure is correct for the lower values, it is bound to be deceptively optimistic about the highest values.

The second consideration is that the user of resistors is often misled because of the fact that there is seldom a clear distinction between those resistors which have erratic behaviour due to a fault in construction or material and those that drift in the normal manner and ultimately exceed some arbitrarily allocated limit. It is, of course, proper that a circuit designer should set a limit to the drift in resistance value which he is prepared to tolerate, and he may equally properly regard any resistor which exceeds such a limit as being defective. However, if he publishes the information which he obtains together with his conclusions concerning the merit of various products, he should make the basis of his statement quite clear. For example, a figure for reliability based upon an arbitrary 1% limit to drift can be misleading to another designer who may be using a 5% design tolerance.

It is our opinion that there is much to be said for a method of presenting performance data for resistors which distinguishes between the incidence of erratics and the ultimate stability of the component.

Accordingly, there would be two curves, that of Fig. 1 which shows the relation between the failure rate due to erratics with time and the curve of Fig. 2 which shows the failure rate due to drift beyond some arbitrary limit. In the case of Fig. 2 the time at which the rate increases will depend upon the arbitrary limits taken to define failure and also upon the type and resistance value of the component that is described.

It should be noted that it is possible to calculate the long-term stability of components from the curve of Fig. 2, since the rate of drift will be the drift limit divided by the period of time which elapses before the curve begins to rise.

By presenting component data in this greater detail it is possible to avoid the misconception that there is a "wear out" characteristic in resistors. Most users of such components will know that the best types do not in fact wear out and are capable of giving a life which, for practical purposes, is infinite. If the drift limit is properly chosen, particularly in collaboration with a component manufacturer, it may be possible to ensure that there is a 99·8% confidence that all resistors will remain within that limit for the life expectation of the apparatus.

R. H. W. Burkett,
Technical Director.

Welwyn Electric Ltd.,
Bedlington,
Northumberland.

Design in Electronics

You claim in your November issue that design is of sufficient importance to discuss as your leader; and yet you denigrate the subject to the extent of stating—" . . . with design coming into the picture as a 'poor second' and purely as an added incentive." This shows an abysmal ignorance of the entire subject and the very attitude which is doing exceptional damage to British trading generally. Starting with components (which is your subject) there is room for vast improvement in the items you discuss—with small components such as resistors and capacitors there is room for better packaging and better marking for easier identification. Knobs and scales need far more attention for functional use and clarity of markings (even on relatively expensive equipment, the spots on top of knobs make accuracy of setting impossible due to parallax error). Knobs generally available are so bad that this Company has designed its own which is costly when one considers the available choice in terms of quantity but not design.

Design is a philosophy—not an added extra. It is as important to have well designed notepaper as leaflets or to have equipment that is as good to look at as it is simple to use. Layout of components is too often a matter of convenience to the engineer designing the circuitry, and not for the user. The services of an industrial designer trained in these matters is invaluable providing he is part of the team and brought in at the beginning. He undoubtedly brings fresh thoughts in layout and presentation and his knowledge of lettering, materials, colours, and new techniques supplements that of the engineers.

This Company believes in this philosophy as a fundamental approach and, as an example, a range of some thirty oddly assorted public address speakers in wood and metal has been reduced to a "family" of seven. These are all related visually, using the same material (resin bonded glass fibre), with a special fabric designed not to sag. This has entailed considerable initial expenditure on engineering, design, and research into new materials; but the result is a range far superior visually as well as technically to anything on the market today at no increase in price; the advertising, leaflets and packaging were considered parallel with the development.

Re-design of existing equipment will obviously cause a slight increase in price. We have shown, however, that increased clarity of controls, the logical layout of a panel and improvement in finish and materials of our speech trainer has increased sales—particularly overseas where they are far more design conscious than the British.

P. E. M. Sharp,
Director and General Manager.

Westrex Co. Ltd.,
152 Coles Green Road,
London, N.W.2.

I am grateful to Mr. Sharp for his views on the Commentary contained in the November issue and I therefore print his letter in full. He is perfectly entitled to his own opinions although I must object to his use of the words "shows an abysmal ignorance of the entire subject". I am aware that good design is an important factor in the production of a component or a piece of equipment and the Commentary did not set out to disprove this. What, in fact, it was intended to do was to point out that quality should not be sacrificed for design.

If one takes a fairly simple example, such as a tape recorder, it is very apparent that there are a number of machines on the market which have been deliberately designed to appeal to the eye of the uninitiated prospective customer but their actual performance, reliability, and expected life leave much to be desired. From the long term point of view, such practice can bring nothing but harm to the manufacturers concerned.

As far as components are concerned, we have been aware of considerable activity in the Industry with respect to their packaging and identification marking but, although I would agree with Mr. Sharp that there is still room for improvement, I would not agree that this particular aspect is as bad as he suggests. Again, the functional requirements of knobs and similar components, although important, are more a question of personal preference—both on the part of the manufacturer and the user—and their design should depend a great deal upon the complexity of the equipment and the expected technical knowledge of the operator.

Design might well be a philosophy, but it is still an extra and must be paid for, in the final analysis, by the customer. If the customer receives good value for his money, then no-one can complain—especially if the price paid compares favourably with goods of similar quality but of poorer design.

The whole subject is basically one of personal opinion. Mr. Sharp claims that his Company's range of public-address speakers is "far superior visually as well as technically to anything on the market today". This, of course, may or may not be true but I am sure that there are a number of people who would disagree with Mr. Sharp simply on the basis of their own aesthetic values and technical requirements. In any event, I would never disagree with any manufacturer raising the price of newly designed equipment provided that the original performance is maintained or is at an even higher level.

Editor.

The Editor will always be pleased to consider items of correspondence for publication. Such communication should, where possible, be typed in double spacing on one side of the paper only. The Editor does not necessarily agree with opinions expressed by correspondents.

PIONEERING TELEVISION

From Marconi's Wireless Telegraph Co. Ltd. we have received this "getting the record straight" potted history of the early days of television development and the parts played by the various pioneers. Although this period has received considerable attention from the press we feel that those concerned with the components industry may have a special interest in the formative years of television.

IN an honoured place at Marconi House, Chelmsford, overlooking a works area where the most modern television transmitters are tested, stands the ancestor of them all—the final amplifier of the vision transmitter which carried the world's first permanent high-definition television service.

A quarter of a century ago—on 2nd November, 1936—the B.B.C. began transmitting programmes from Alexandra Palace. At the onset two rival systems, the Baird and the Marconi-E.M.I., were used to judge under practical conditions which was the better; the Marconi-E.M.I. system proved to be the most popular and, as from 6th February, 1937 this system continued alone.

In this fashion a new pattern of home entertainment and, incidentally, a new suburban skyline, was born.

Not the least remarkable aspect of the chosen system has been its endurance. The Marconi-E.M.I. team of engineers, who, for some years previously had laboured on the project, had no precedents to guide them in the design of television stations; one might therefore have expected that the whole system would have had to be modified out of all recognition in a matter of months. Yet the standards devised well over a quarter of a century ago still carry what is generally conceded to be the best television service in the world, whilst the transmitters and aerials continued to give exemplary service until 1956, only retiring when the B.B.C. station at Crystal Palace began operation in that year.

Ironically, whilst the name of John Logie Baird is familiar to all, the names of Shoenberg, Blumlein, N. E. Davis, Franklin and others of the brilliant team who gave us television as we know it today are virtually unknown outside engineering circles—doubtless because they worked in secret as a team on a system which derived nothing from that used by Baird. Notwithstanding, there is a memorial to their genius in practically every home in the country—the ubiquitous "telly".

The Origins of Television

Even twenty-five years ago television was no new concept. The expression was coined as long ago as 1900, and the ultimate roots go back at least as far as 1847, when Bakewell devised a system of transmitting still pictures over telegraph wires which incorporated the vital principle of scanning the subject piecemeal in a series of lines.

Attention was later turned to the problem of transmitting actual images and there were many experimenters in the field. A major development occurred in 1884, when Nipkow, a German engineer, patented an "Electric Telescope" which embodied a spiral of holes in rotating discs at both the transmitting and receiving end, with the discs operating in synchronism to achieve a scanning process. This important advance, paradoxically, was to lead many subsequent workers, including Baird, along a fruitless path.

Nipkow's device did not work but only because two key components were not then in existence—an efficient light-sensitive cell and the amplifying thermionic valve. In the years following, many proposals for a method of achieving television were put forward, but all failed for the same reasons.

A further advance came in 1907, when Rosing, a Russian professor, devised an apparatus which used mirror drum scanning at the transmitter and a cathode-ray tube (then in existence but in a very rudimentary state) for presentation of the received picture. This was followed in 1908 by a remarkable proposal by Campbell Swinton, one of the outstanding electrical engineers of his day, who outlined a scheme for scanning the image at the transmitter by a special type of cathode-ray tube, and presenting the picture on such a tube at the receiver.

Campbell Swinton elaborated on his proposal in 1911, but never carried it beyond the theoretical stage; in fact he could not, because neither the special tube nor an efficient thermionic valve amplifier was available. Nevertheless, beyond dispute, Campbell Swinton's proposal embodied the basic principles of today's high definition television systems.

During the years of World War I nothing significant was done in television research, but a very great deal was done in radio communication, particularly in improvements on the thermionic valve. When, after the war, the latter made broadcasting possible, television, which had hitherto been thought of only in terms of transmission along wires, had a new door opened to it unawares.

In the early 1920's interest in television was revived by a few workers, notably Baird in Britain and Jenkins in America. Baird experimented with Nipkow's apparatus of 1884 and, by now having amplifiers at his disposal, succeeded in transmitting shadows over a distance of a few feet in 1923. By 1926 he was able to give a demonstration of images transmitted with some degree of light and shade—very small, very low in definition and flickering, but undeniably pictures—the first in the world.

In America, Jenkins, using a modified Nipkow system, was hot at his heels. Baird, spurred on by his initial success and the knowledge that others were not far behind, demonstrated in quick succession Noctovision (televising in darkness, using infra-red), trans-atlantic television, colour television, outside broadcast television and 3-D television—all within three years!

Baird, in a natural desire to recoup his Company's outlay, wished to put receivers (which he called "Televisors") on the market, but to do this a public service had first to be established. Pressure was brought to bear on the B.B.C. for the provision of this. Eventually, and rather reluctantly, two medium-wave transmitters (one for vision, one for sound) were put at Baird's disposal for a limited experimental service after normal programme hours. This began in 1930.

The B.B.C.'s reluctance was based on realism. Although the Baird 30 line, 12½ frame transmissions were exciting as a novelty, the entertainment value was negligible, the received images being tiny and almost completely lacking in detail. Furthermore, it was known at the time that big electronics organizations in this country and others elsewhere were actively interested in television, and that Campbell Swinton's ideas had been resurrected and showed promise.

Zworykin, of America—in his youth a pupil of Rosing's—had begun experiments on an all-electronic system in 1923, and if this came to fruition it would patently be much more acceptable than any mechanical scanning system could be. In 1929 Zworykin gave a public demonstration which proved this beyond doubt, although his equipment was still in the laboratory stage.

In Britain, Electric & Musical Industries Ltd. and the Marconi Company were both actively interested in television; furthermore, in the 1920's Marconi's had carried out intensive work on the development of a high-speed system of facsimile (still picture) transmission and in so doing had encountered and solved many of the problems inherent in the transmission of the high-definition television signals which were being visualized.

When, in 1931, E.M.I. Ltd. developed a 120-line mirror drum film scanner, the ultra-short wave transmitter necessary to radiate the signals was ordered from Marconi's. Thus began a close liaison between the two Companies' television development groups which intensified when in 1932 E.M.I.'s patented an electronic camera tube (the "Emitron"). The inter-company association reached a logical conclusion in 1934 when the Marconi-E.M.I. Television Co. Ltd. was formed.

Baird, in the meantime, was keeping in the public eye by such matters as televising the Derby in 1931 and 1932 (using his 30-line system), and by improving the size of the picture on his Televisors. He also developed a 120-line mirror drum system which he demonstrated in 1933.

In 1934 a Committee under Lord Selsdon was set up by the British Government to look into the possibility of establishing a permanent television service. In the following January it made its report, which was to the effect that a high definition service should be established as soon as possible and that steps should be taken to find the most suitable system. In practice, this meant Baird *versus* Marconi-E.M.I.

In due course the rival Companies installed their vision equipment at Alexandra Palace, the chosen site of the London station. A common sound transmitter and a common aerial system, both manufactured by Marconi's, were used.

The Baird equipment employed 240-line scanning with 25 pictures per second, the scanning process being carried out by vastly improved Nipkow discs running at 6,000 rev/min in a vacuum. Spotlight scanning was used for head-and-shoulders work, but for general scenes an indirect system was employed, which consisted of an intermediate film scanner which filmed the scene and developed, washed and fixed the pictures within 30 seconds, whereupon they were scanned for transmission.

The Marconi-E.M.I. system operated on 405 lines with all-electronic interlaced scanning, using Emitron cameras as the picture source. Although the picture rate was nominally 25 per second the interlacing provided an effective repetition rate of 50 per second with a marked reduction in flicker.

On 2nd November the station was formally opened, with Baird's and Marconi-E.M.I. operating their equipments on alternate weeks. The few receivers on offer at the time incorporated cathode-ray display tubes and had a switch to change over from one line standard to the other.

On 5th February, 1937 the Postmaster General announced that henceforth only one system would handle the transmissions—the Marconi-E.M.I. Baird had paid the penalty for his adherence to mechanical scanning; had he changed to an electronic system in the early 1930's the issue might well have been different (he did, in fact, during the course of the "trial" transmissions change to an electronic camera embodying a Farnsworth tube but by then it was too late).

In this fashion began the world's first public television service, well ahead of the U.S.A., which did not start public transmissions until 30th April, 1939.

★ ★ ★

New method of "growing" GERMANIUM CRYSTALS

A $2 million development contract in the field of "molecular electronics" has recently been awarded to the Westinghouse Electric Corporation by the U.S. Air Research and Development Command. The new development is based on a revolutionary method of "growing" germanium crystals as thin, uniform flat ribbons.

The raw product was in the shape of a circular ingot and involved tedious slicing and polishing of the material. Research now shows the material may be literally "grown" as thin, uniform flat ribbons, and the new method may lead to the development of outer-space electronic equipment 1,000 times smaller and lighter than anything now in existence.

The first objective is to be able to design equipment which can be relied upon to function throughout its expected life cycle. The second is to greatly reduce the number of thermal energy consumers in electronic systems. The third is to provide the means to increase by several orders of magnitude the amount of electronic functions performed per unit of volume.

Carrying this new concept through to its conclusion and to the development of an overall system, the promise of drastic reductions in size, weight, and power requirements for electronic equipment could allow space vehicles to perform a greater number and wider range of functions.

The material grows directly in the exact form in which this semiconducting material is used for practical purposes in transistors and similar devices.

The molecular engineering concept deals with dimensions comparable to molecules themselves, and is a new approach to the building of electronic systems based on recent research concerning the structure of materials.

Dendritic germanium has broadened contemporary thinking about the whole technology of solid-state devices of the future. There is now a possibility that a machine could be developed which could continuously, automatically, and at high speed, turn out finished transistors directly from an input of raw germanium and the other materials required to put a transistor into final form.

In use, these very small pieces of crystal could perform the functions that now require as many as a dozen present-day components using conventional circuitry. Two possible functions of the minute equipment are the sensing of environmental conditions and the transmission of the data to any desired location. Feasibility studies are being conducted in infra-red, reconnaissance, flight control, communications, and other applications.

The most modern system used today to measure the intensity of light in space has a volume of about one cubic inch and a weight of approximately 7g. The U.S. Air Force has conducted demonstrations with a Westinghouse light telemetry sub-system which has a volume of one one-thousandth of a cubic inch and a total weight of two one-hundredths of a gram. This equipment not only measures change in light intensity but also produces a signal capable of transmission to relate the degree of change in intensity. The number of component parts in the telemetry sub-system was cut from 14 to 1 and the number of soldered connections was reduced from 15 to 2, thereby offering a tremendous potential to reliability.

Germanium being grown in ribbon form at the Westinghouse Research Laboratory.

The new technique for growing germanium was the work of two company research physicists, Dr. R. L. Longini and Dr. A. I. Bennett, both of the solid-state physics department of the Westinghouse Research Laboratories.

The ease of processing dendritic germanium into usable form contrasts sharply with present practices. Because germanium is so hard and brittle, the conventional cutting of the slices is done with a diamond-tipped saw, and each slice has to be three to five times the desired thickness simply to keep it from shattering.

The slices must then be ground down to the required thickness, further cut into small squares, and finally polished. Only then is the germanium ready to be fashioned into finished transistors or other devices. As a result of all this cutting and polishing, about 80 per cent of the original ingot is wasted.

Not only is dendritic germanium of the proper thickness for direct use, but its ultra-smooth, mirror-like surfaces need no grinding or polishing of any kind. As a result, the usual time-consuming and expensive processing of the germanium into usable form is virtually eliminated.

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AYLING INDUSTRIES GROUP

H. 491

NEW COMPONENTS

Le Boeuf Relays

L. E. Simmonds Ltd. have recently been appointed sole concessionaires in the United Kingdom and Commonwealth for relays made by A. le Boeuf et Fils of Colombes, France. Typical of the new range is the moving-coil relay Type SB 21 which offers a number of valuable features, notably extreme sensitivity and small size.

Moving-coil relay type SB 21.

According to the type of coil-winding used, the operating current may be as low as 1 µA with a 21 kΩ coil or as high as 10 mA with a 0·3 Ω coil. The relay may incorporate a rectifier or a thermocouple to enable it to be used on alternating currents of almost any frequency. The coil may be double-wound, providing differential deflection and this type may also have a logarithmic law so that the two currents are multiplied together (or divided one into the other.)

The movement may be end or centre-stable and the contacts may be either 1 make plus 1 break or 2 make. The position of the moving contact and the variable fixed contacts are shown by pointers on a normal meter scale on the top of the relay, the fixed contacts being set by means of two adjusting screws adjacent to the scale.

The insulation of the movement and the contacts from the frame is flashed-tested to 500 V and the insulation resistance exceeds 10,000 MΩ.

The relay is constructed in a substantial cylindrical metal case 3¼ in. long by 1½ in. diam. and is arranged to plug into a standard International Octal valve-holder.

REC 101 *for further details.*

Ceramic-cased Tunnel Diodes

The operating frequency of tunnel diodes has been raised by a technique of miniature ceramic encapsulation developed by Standard Telephones and Cables Ltd.

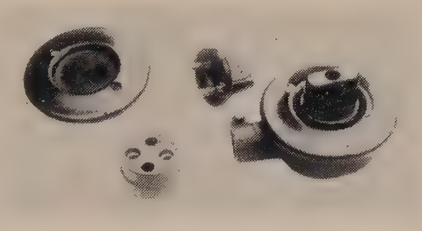
The extremely small size (5·6 mm diam. less tabs) of these new devices and their tab-ended configuration have reduced their inductance to such an extent that a typical limiting frequency of oscillation of 900 Mc/s is now attainable.

A single version, known as the JK30A, is now in production. It is being followed by a new version incorporating a matched pair of tunnel diodes and forming a single integral unit having three tabs. These units are matched for peak current and capacitance and are intended for applications in the computer field. They may be used in high speed logic and counting circuits or as the threshold amplifier/gate at the input of a pulse amplifier.

REC 102 *for further details.*

Non-reversible Plug Socket

The photograph shows the non-reversible plug and socket developed by George Turnock Ltd. It can be seen that there is a surface socket and a flush socket and the latter fits on to a standard 2 in. B.E.S.A. box.



Non-reversible plug and socket.

This component should be of interest to electronic and radio engineers, as it is non-reversible, making it impossible to put an ordinary live 2-pin plug into the socket.

REC 103 *for further details.*

Microminiature Computer

The Aeronautical Systems Division, U.S. Air Force, and Texas Instruments Incorporated, Dallas, Texas, recently demonstrated a microminiature digital computer utilizing semiconductor networks.

The advanced experimental equipment has a total volume of only 6·3 cubic inches and weighs only 10 oz. It provides the identical electrical functions of a computer using conventional components which is 150 times its size and 48 times its weight and which also was demonstrated for purposes of comparison. It uses 587 digital circuits, semiconductor networks, each formed within a minute bar of silicon material. The larger computer uses 8,500 conventional components and has a volume of 1,000 cubic inches and weight of 480 oz.

The experimental computer was developed as a part of the Molecular Electronic Programme under the technical guidance of the Electronic Technology Laboratory, Aeronautics Systems Division. It was built by Texas Instruments as a practical application of semiconductor networks, and the successful use of such networks in this computer demonstrates their capability for solving the problems of interconnections, thermal dissipation, electrical interaction, and maintenance of high-density packaging in equipments of great complexity.

This demonstration emphasized the suitability of semiconductor networks for many of today's military digital equipment design programmes. It is expected they will have wide application in guidance, telemetry and other information processing equipments. The important features of this new product advance, aside from size and weight reduction, are the potential for improved reliability and reduced cost.

REC 104 *for further details.*

Zip for Cable-forms

The Plastics Division of Hellermann Ltd. has developed an entirely new idea in cable-binding—"Helazipp". This is a flexible p.v.c. tape with interlocking beading along each edge which, when wrapped round the length of cables, will interlock simply by zipping the two sides together.

"Helazipp" tubing.

This plastic cable-covering, specially designed for varied atmospheric conditions, is dust and moisture proof, extremely tough and light-weight. It is available in either black or transparent, and allows wires to be traced without any difficulty or without having to undo work previously carried out, by un-zipping the covering. It can also be used in place of conduit or in certain circumstances as a cover for conduit giving protection from corrosion.

The wall thickness of Helazipp is 0·015 to 0·020 in. in the following sizes—(inside diameter) ⅜, ½, ¾, 1, 1½, 2, 2½, and 3 in.

REC 105 *for further details.*

Strain Gauge Amplifier

The Fenlow Electronics Ltd. amplifier, Type A.3, is designed for the purpose of amplifying signals from thermocouples and strain gauges in applications where the signal available is very small. The amplifier contains an auxiliary drift correction channel with the chopping transistor and other components contained in a temperature stabilized block at 60°C.

The d.c. gain of the amplifier is in excess of 2×10^5, this being reduced by external feedback resistors in normal use. The amplifier has a bandwidth of 1 kc/s, and noise referred to the input is 5 µV. The input impedance is approximately 2 Ω, and for strain gauge use this is swamped by external resistors.

Drift referred to the input (after an initial period of warming up) is less than 5µV and the power supply requirements are ±15 V, the output swing being ±9 V into 1 Ω.

The current requirements are, on the negative supply 300 mA falling to 80 mA when the temperature controlled block reaches 60°C and 80 mA on the positive supply.

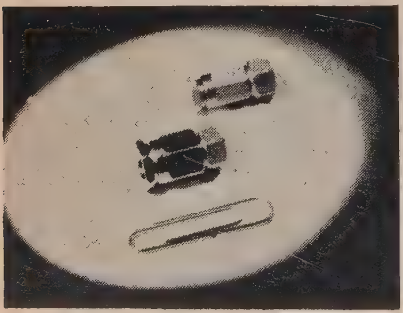
REC 106 *for further details.*

R.F. Connectors

To accommodate some of the older miniature r.f. cables which are considerably larger in diameter than the latest Service specification subminiature cables, the Sealectro Corporation is offering the "ConheX" Types 3040 and 3050 cable plugs. While these connectors have a larger body and clamping components than the regular "ConheX" 75 Ω series, they will mate with the 75 Ω "Conhex" receptacles and jacks.

REC 107 *for further details.*

Large Type 3040 *connector beside the* 75 Ω *size.*



NuVistor Triode

RCA Great Britain Ltd. has developed the 6DS4 high-mu triode—a new member of its growing family of NuVistor tubes. This new tube, formerly known by its developmental number A15251D, is intended for use as a grounded-cathode, neutralized r.f. amplifier tube in v.h.f. tuners of television and f.m. receivers.

The exceptional performance claimed for the 6DS4 in fringe areas and other locations where signal levels are weak is made possible by the following features:

Semi-remote-cutoff characteristics, excellent signal power gain, low noise factor, excellent stability and exceptional uniformity of characteristics from tube to tube.

REC 108 *for further details.*

Silicon Strain Gauge

The development of the flexible silicon strain gauge represents a significant advance in strain measurement technique. The conventional metal strain gauge has reached the stage where further development yields only marginal improvement in gauge factor which is normally in the region of 2. The semiconductor strain gauge now provides gauge factors of up to 130. This means that a conventional strain bridge with an output of, say, 20 mV can be replaced by a semiconductor bridge producing 1·3 V (or more than 5 V from a 4 arm active bridge) hence the cost of an amplifier can be eliminated in many applications. The marked increase in signal-to-noise ratio and low impedance permits measurements, under either static or dynamic conditions, in the sub-microstrain region hitherto unattainable, using metal gauges.

The silicon strain gauge was originally developed by Micro Systems Incorporated, California, for military and space applications. Subsequent research has evolved the comprehensive Microsensor range of more than 30 types with resistance of 120 Ω up to 1,000 Ω and an active gauge length of 0·050 in. up to 0·5 in. The maximum operating strain is over 3,000 µin./in. with a transverse strain sensitivity of less than 1%. Microsensor gauges are available unmounted or mounted on an epoxy base carrier as shown in the accompanying photograph. In either case conventional bonding techniques are employed. The minimum radius of curvature is 0·1 in.

The single crystal silicon elements are said to be remarkably robust. They have been used successfully in rigorous applications such as the measurement of ship's propellor shaft forces during trans-Atlantic trials, and in numerous structural strain applications in aircraft, missiles and satellites.

Silicon strain gauge.

Both positive and negative gauge factors are available to provide temperature compensation. The positive gauge factor elements increase in resistance with applied strain in the same manner as conventional gauges; the negative gauge factor units decrease in resistance with strain. Since both *p* and *n* types exhibit similar temperature characteristics (increase in resistance with temperature), the temperature compensation is achieved by employing the two elements in adjacent bridge arms. The latest addition to the Microsensor range uses a *p* and *n* type gauge on a single epoxy base carrier to form a self temperature compensated element with a gauge factor of 250 for a 2-arm active bridge.

A new range of pressure transducers is also available using 4 gauges in full bridge connection to produce 1 V output for pressure ranges 0–50 lb/in.^{2} (Abs.) to 0–500lb/in.^{2} (Abs.). The transducers are only ¼ in. diam. and ¼ in. long with a natural frequency of 40 kc/s.

The sole distributors for the above are Scientific Furnishings Ltd.

REC 109 *for further details.*

Rechargeable Batteries

The rechargeable DEAC 6 V batteries, developed for the portable television set market and marketed in the United Kingdom by G. A. Stanley Palmer & Co. Ltd., are claimed to solve one of the major problems that have beset portable television set manufacturers for many years.

The batteries, which are available in either a 4 A-h or a 6 A-h capacity, are new cells in a new form. They are said to be extremely reliable and are guaranteed for a year or a minimum of 300 recharges, whichever is the less. In fact, they are thought to be the only batteries of their type on the market.

Each battery, 4 A-h and 6 A-h, can supply 2 A and 3 A outputs respectively for five hours of continuous use. When the portable set is plugged into the household mains supply, the batteries are automatically recharged *via* circuitry in the set. One pair of similar capacity batteries is required per set to produce the required 12 V.

REC 110 *for further details.*

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V.H.F. Transistor

Now available from Mullard in TO-18 encapsulation is the Type AF212 low-noise germanium alloy-diffused transistor developed specifically for amplification of frequencies up to 200 Mc/s. This transistor gives a noise figure of only 6 dB at 200 Mc/s and a power gain in common emitter of greater than 10 dB.

Although particularly suitable for "front end" service in v.h.f. communications equipment, the high stability of its frequency conscious characteristics enables the AFZ212 to be used in a wide variety of video and other broad-band high-frequency applications.

A current amplification factor of 60 is typical and the maximum collector-base voltage is −20 V and maximum collector-emitter voltage is −10 V at the full collector current rating of 10 mA. In an ambient temperature of 25°C the collector leakage current is typically 1 μA with a collector-base voltage of −6 V. Maximum junction temperature for continuous operation is 75°C and the thermal resistance is 0·6°C/mW, permitting a dissipation of 50 mW in an ambient temperature of 45°C.

The TO-18 encapsulation measures 5·3 mm length by 4·8 mm diameter. An inter-lead shield connected to the metal case is provided.

REC 111 *for further details.*

Transistors

Newmarket Transistors Ltd. announce the NKT 501-504 series which are very high current, high power, *p-n-p* alloy-junction germanium transistors in an industry-standard TO36 encapsulation. They are designed for amplification, control and switching applications in the industrial and services field where quality and reliability are mandatory.

The distinguishing features of the NKT 500 range are the very high current ratings (up to 25 A), a guaranteed minimum current gain of 12 at the maximum rated collector current, high power rating and voltage ratings of 60 V and 30 V. The low saturation voltage results in low-self dissipation when used for switching applications. The drive voltage for peak collector current is low and distortion is minimized by controlled beta fall off.

All units are cold welded for reliability, stringent surface treatment and high temperature ageing ensure parameter stability. Each unit is tested fully for electrical characteristics.

REC 112 *for further details.*

Colour Picture Tube

RCA Great Britain Ltd. announce a new hi-fidelity colour picture tube, Type RCA-21FJP22. This new tube has a bonded "Glare-proof" window and retains the outstanding features of the recently announced all-sulphide-screen type.

The tube is said to provide greatly improved picture contrast, eliminate the need for external safety glass in the receiver and practically eliminates annoying room-light reflections.

REC 113 *for further details.*

Synchronous Motor

The Electrical Remote Control Co. Ltd. has introduced a new miniature synchronous motor-driven timer especially designed for the quantity market where a highly competitive price is of major importance.

Its extreme simplicity and small size should recommend it for many applications. This type of timing device is frequently essential for automatic operation of domestic oil firing equipment, vending machines, etc. The timer can close one electrical circuit for a specified interval during a fixed continuously repeating overall timing cycle, or, when initiated by external switch or push button, a fixed single cycle and stop switching action can be obtained.

Synchronous motor.

REC 114 *for further details.*

Retentive Relay

Magnetic Devices Ltd. has been appointed sole concessionaire for the manufacture and sale of the Remanent Relay developed by the Telephone Manufacturing Co. Ltd.

The series 355 Remanent relay remains operated after removal of the energizing current and will remain operational indefinitely until the application of a de-energizing pulse. It is based on the Post Office 3,000 relay, and differs only in respect of the core and armature.

The core has a high retentivity. They "Latch-up" on receipt of a signal and remain so until the core flux is cancelled. This is effected by a current reversal in the operate winding or by use of a separate winding.

A "suicide" contact, which must be wired in series with the release winding, ensures that the release current does not produce excessive flux in the reverse direction thus tending to re-operate the relay. This is fitted to the relay as standard.

REC 115 *for further details.*

Printed-circuit Kits

An average of 15 minutes is said to be all the time required in which to produce prototype printed-circuit boards by the Electrosil "Fotoceram" method.

A complete kit is available from Electrosil Ltd. which enables the designer to mark out, mask and etch a complete board with the assurance of having a reliable circuit. The kit comprises an etching tray, two grid boards, two bags of etching compound, ball-point resist "pen" and a card of masking tape. The basis of the board is a copper-clad ceramic formed by the heat treatment of glass. The copper plate is virtually integral and will withstand repeated soldering (up to 50 times). Standard component mounting holes are 0·052 in. nominal on 0·1 in. centres and are through-copper-plated.

REC 116 *for further details.*

Variable Capacitor

English Electric Valve Co. Ltd., announce the addition of the Type U240/15 to their range of high-vacuum variable capacitors. The first application has been its use in the high-power stages of 30 kW transmitters at the G.P.O. Radio Station at Rugby where it is smaller and lighter than the capacitor it replaces.

The U240/15 is designed to work at 15 kV with a linear capacity variation from 10 to 240 pF. At 30 Mc/s the maximum current rating is 50 A.

REC 117 *for further details.*

Screened Side-entry Plug

This new, and originally styled, screen side-entry jack plug has originated from the popular acceptance of the P.539 standard and P.529 miniature screened jack plugs with internal cable clamping which was recently announced by A. F. Bulgin & Co. Ltd. Conforming to the British Standard 666 it is available either hard gold plated or chrome plated. The plug is ideal for use with tape recorders, stereophonic equipment, electro-medical appliances, telecommunication equipment, etc. and its modern design should prove very popular.

REC 118 *for further details.*

Screened, side-entry plug.

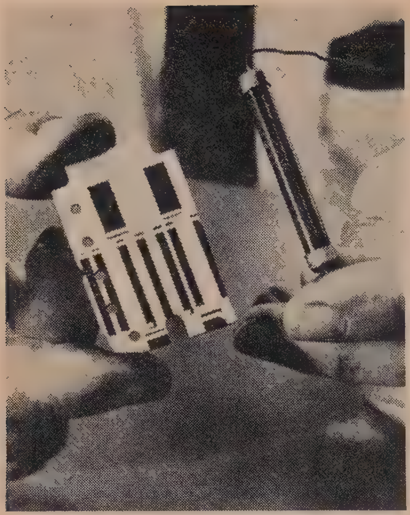


Fig. 1. The above picture shows a typical application by the silk screen process of Du Pont's new resistor compositions which permit greater flexibility in designing miniaturized circuitry.

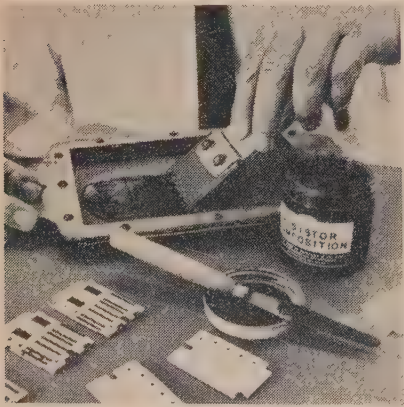
Resistor Coatings

Greater flexibility in designing miniaturized electronic equipment and printed circuitry is now possible as a result of the recent development by the Du Pont Company of easy-to-apply, fired-on resistor compositions with varied resistance values.

These new compositions are specially treated metal powders and glass particles dispersed in a suitable organic solvent. They can be applied to glass or ceramic bases by the usual dipping, brushing, spraying, or screen printing techniques. The compositions are available in three approximate resistance values: 500; 3,500; and 10,000 Ω per square per mil thick film.

Since they can be blended to obtain intermediate values, the designer is no longer limited by the physical shape of resistor materials and can fit the resistor to the circuit by varying the composition.

Fig. 2. A completed blank and a rod-type resistor after firing. The resistor appears as a glossy or semi-glossy enamel film of high quality.



When fired, the resistor appears as a glossy or semi-glossy brown-black enamel film of high quality which is relatively insensitive to moisture, abrasion, and to reasonably high ambient temperatures (125°C).

Printed resistor patterns and coated rods show only small variations in resistivity under varying conditions of humidity, temperature, overload and voltage.

The new resistor compositions manufactured, in the United States by E. I. du Pont de Nemours & Company, are distributed in the United Kingdom and Ireland by Brown & Forth Ltd.

REC 119 *for further details.*

Moulded Fibre

Hawley Products Ltd. exhibited a wide range of moulded fibre items for domestic and industrial applications at the 1961 Engineering, Materials & Design Exhibition.

Hawley moulded fibre combines flexibility and resistance to impact with a weight less than one-eighth of the equivalent thickness of steel or brass; tensile strengths can be made to vary from 2,000 to 7,000 lb/in.^2

The items on show included suitcases, packaging, loudspeaker cones, factory work trays and motor car gearbox covers and glove compartments. A wide range of finishes can be applied including resin impregnation, lacquer, enamel, flock spray, leather, leatherette and p.v.c.

REC 120 *for further details.*

Sleeved Transistors

RCA's silicon diffused-junction rectifiers in the small flangeless hermetically sealed JEDEC TO-1 case with axial leads—Types 1N3193, 1N3194, 1N3195, and 1N3196—are now available with insulating sleeves. Designated 1N3253, 1N3254, 1N3255, and 1N3256, respectively, these low-cost, compact, cylindrical-design rectifiers with axial leads have a plastic, optically clear insulating sleeve which has a high dielectric strength.

The flangeless, metal case has a single glass-to-metal hermetic seal and fits easily into standard assembly and mounting procedures for simple handling and installation.

REC 121 *for further details.*

Ceramic Triode

A new type of valve for industrial radio-frequency heating applications has been introduced by Standard Telephones and Cables Ltd. This is a power triode and has an all-ceramic envelope which permits operation at much higher frequencies than were possible with similar valves having glass envelopes. It is believed to be the first of its kind to be marketed in the United Kingdom.

The first valve of this type is known as the 3RC/223E and is a near equivalent to the established 3J-Q-R-Z/222E family of valves which operate from a 6,000 V supply and develop up to 24 kW of output power at a high efficiency.

Whereas the anode voltage of the glass versions must be lowered for operation at frequencies above 50 Mc/s, these ceramic valves may be operated at full rated voltage at up to 100 Mc/s. Other improvements include a shorter coaxial stem for ease of cavity mounting; and an improved cathode with a greater reserve of emission. The valve is available in forced-air-cooled, vapour-cooled and water-cooled versions.

REC 122 *for further details.*

Miniature Transistors

The growing computer transistor line developed by RCA now includes two new silicon *n-p-n* transistors—RCA-2N1708 and 2N708 for military and industrial equipment.

The RCA-2N1708 is claimed to be the first and fastest silicon planar-epitaxial switching transistor in the TO-46 package and features epitaxial structure which ensures a low collector saturation voltage at a high collector current.

The RCA-2N708 planar type is designed for very high-speed switching applications and has planar construction which insures low collector cut-off current and exceptional stability.

The storage time of both the above is 25 μs.

REC 123 *for further details.*

Dust Protected Variable Transformers

Philips of Eindhoven announce the introduction of a range of dust-protecting enclosures for their variable transformers.

One of the advantages of these new enclosures is that it is no longer necessary to site variable transformers outside dust laden areas—they can now be used "on-site" even though the atmosphere contains abrasive or corrosive dust.

It is claimed that no de-rating of the transformers is necessary, providing the ambient temperature does not exceed approximately 25°C.

The enclosures are of welded sheet-steel construction with a stove enamel hammer grey finish and are so far available for all ratings except the 20 A model.

If it is required to isolate the transformer from the supply when the cover is removed, provision is made for fitting a single-pole plunger switch operated by the cover.

The sole distributors in the United Kingdom are Research & Control Instruments Ltd.

REC 124 *for further details.*

Continued on page 954

MANUFACTURERS' PUBLICATIONS

Plastic Materials

Three new publications are available from Polypenco Ltd. The first describes "Fluorosint" a reinforced t.f.c. resin which offers substantial operational advantages over conventional p.t.f.e. in its performance at elevated temperatures, etc. "Nylatron G.S.", a molybdenum disulphide filled Nylon 66, exhibits superior mechanical and bearing properties whilst maintaining the electrical and chemical characteristics of nylon. Nyloflow flexible pressure hose is the subject of the third leaflet. This is a top grade, highly flexible, high-pressure hose of all-bonded construction with nylon inner core for hydraulic, pneumatic, fuel, freon, anhydrous ammonia, lubrication, solvent or hot paint lines.

REC 125 *for further details.*

Polyester Story

From British Resin Products Ltd., comes a well-illustrated twenty-four page booklet entitled *The Cellobond Polyester Story*. Nine major industries contribute photographs which show how the number of applications of polyester/glass are increasing. This material has a high strength-to-weight ratio, high resistance to chemicals and can stand weathering without the protection of paint.

REC 126 *for further details.*

Electromechanical Components

Data sheets on four electromechanical components, recently added to the Ericcson range, cover a multiple miniature relay unit, a solar switch, a G.P.S.T. plug-in relay and the Type 53 a.c. relays. Also described is a transistor relay capable of being operated or released by the application of a pulse source of the order of 4 μs duration at a repetition frequency of the order of 100 c/s.

REC 127 *for further details.*

Pyrometer Sheaths

Morganite Research and Development Ltd., have provided information in leaflet form on their "Metamic" pyrometer sheaths. Three grades are described for use in different temperature ranges for dip and continuous immersion. "Metamic" sheaths are described as combining the advantages of ceramic sheaths with those of metal.

REC 128 *for further details.*

Investment Casting

Trucast Ltd. have issued a second edition of their booklet describing this process and its applications. Basically, investment casting requires the production of an expendable wax model, which is then surrounded by refractory to which heat is applied to bond it into a casting mould. The wax is melted away by this heating and metal is then poured into the mould. Finally after cooling the shell is broken away and the casting extracted.

REC 129 *for further details.*

Automatic Wafer Sorter

Engineering and Scientific Ltd., the U.K. distributors for Censor of Liechtenstein have issued a leaflet describing an instrument for measuring and sorting wafers for the transistor and rectifier industry. The machine automatically feeds, gauges, determines the tolerance and sorts germanium or silicon wafers according to their thickness. The machine has facilities for dividing the components into ten counted groups and three extreme groups (samples too large, too small, or adhering to one another), and the limits of the individual sorting groups can be infinitely varied between 1·0 and 20 μ. An engineer's page is included in the leaflet which describes the operation of the sorter in detail.

REC 130 *for further details.*

Racal Tachometer

The SA 509 tachometer developed for direct measurement of jet engine speeds is featured in *Racal Review*. Other short news items concern the use of the RA 17 receiver in conjunction with a Mufex weather chart recorder, details of RA 17 h.f. communications receivers and of the Racal h.f. radio telephone system in Assam.

REC 131 *for further details.*

Univac News Features Computer

From Remington Rand Ltd., Vol. 1, No. 4, of *Univac News* deals mainly with the new solid state 11 computer with both core and drum storage. This leaflet also contains details on the Univac LARC 11 installation for the U.S. Navy.

REC 132 *for further details.*

Analogue Computer

E.M.I. Instrument Division have issued details of the Emiac 11 general purpose analogue computer which is capable of studying the performance of complete guided weapon and aircraft systems before they leave the drawing board. The flexibility of this computer is increased by the use of "C" boxes which plug into a standard range of amplifiers for addition, integration, sign reversal, multiplication, and division of junction generation. A series of application examples and results are given which are applicable to all industries.

REC 133 *for further details.*

Murphy News

Volume 30, No. 10, of *Murphy News* deals mainly with the marketing of television and radio receivers but it also gives an interesting description of the ultrasonic remote control device used with domestic television receivers. Another article gives details of the B581 personal portable radio and discusses the misuse of this class of radio.

REC 134 *for further details.*

RE 321 Tape Recorder

From the E.M.I. Recording and Relay Equipment Division comes news of the model RE 321 tape recorder which is particularly suitable for on-the-spot reporting. Completely transistorized electronics and an improved tape transport mechanism are two of the features of this completely mobile recorder which is powered by eight standard 1½ V torch cells. A complete description and technical specification is included.

REC 135 *for further details.*

Microphones

Lustraphone Ltd. have issued a leaflet on noise-cancelling microphones for associated headsets of pre-amplifiers. All these components are for use in applications where high ambient noise exists. The microphones are designed primarily for highly effective noise cancelling characteristics and are, therefore, close talking instruments and directional. Technical specifications are included.

REC 136 *for further details.*

Electronic Post

The autumn edition of this publication by E.M.I. features the European Common Market and follows with a series of Television Jubilee articles on the past, present and future of television. Subsequent articles cover closed circuit television, the EMIDEC 2400 computer which will soon be processing data for the Government Graduated Pension Scheme, the Rotobug driverless tractor used in Rootes stores and the new automatic plotting system which was demonstrated recently to the Western nations.

REC 137 *for further details.*

Marking and Masking Tapes

Tape Times, the house journal of John Gosheron and Co. Ltd., gives details of the applications of the many different tapes manufactured by the Company. These tapes have obvious use for component manufacturers and users for identification, protection, and sealing purposes.

REC 138 *for further details.*

Bulgin 1962 Catalogue

From crocodile clips to bulb extractors, the new Bulgin catalogue contains a wealth of information on all the components manufactured by the Company. Using this well-indexed catalogue the design engineer can find most of the parts required for the connecting, control, indication and switching of power supplies used in electronic equipment.

REC 139 *for further details.*

Terminal Catalogue

"Phoenix" quick fix terminals are the subject of a catalogue issued by H. Knumann and Co., Essen. These terminals are designed to clip on a common mounting rail and have ratings between 20-300 A. The "Katalog" is well illustrated with a number of assembly methods of control circuits and the text is printed in five languages. Another indication of the thoroughness of preparation is that the mounting accessories even include the correct size of screwdrivers. The sole British agent is D. J. Equipment (Hersham) Ltd.

REC 140 *for further details.*

Clamps

Sterling Instrument of Port Washington, N.Y., U.S.A., have a new 40-page catalogue giving details of over one hundred and fifty different types of miniature instrument clamps. There are ten categories of clamps including synchro mounting and locking.

REC 141 *for further details.*

Electrical Equipment Catalogue

A full colour 1962 catalogue of electrical accessories has been received from M.K. Electric Ltd., which gives details of plugs and sockets, switches and fuses for domestic and industrial use. Anybody connected with the mains supply side of the laboratory, office or house would find this, and the M.K. leaflet on adequate wiring, very informative.

REC 142 *for further details.*

Plastic Powders

Dohm plastic fine powders for metal dip-coating, flame spraying and textile coating are the subject of news sheet No. 1 recently issued by the Company. A combination of technical process information and application examples indicates that this series should prove useful to component manufacturers with plastic coating problems.

REC 143 *for further details.*

News Bulletin from S.T.C.

The Standard Telephones & Cables Ltd. *News Bulletin* features the Company's activities at the British Trade Fair Moscow and other news items include the new 12 Mc/s cable system, an automatic television direction finder, Ireland's first inland microwave telephone system and various marine applications.

REC 144 *for further details.*

Atlas Computer

The Ferranti *Computer World* leads with news of the Atlas computer ordered by the Nation Institute for Research in Nuclear Science. Other items are a two page spread on the current range of Ferranti computers and a thirty point summary of information on these computers.

REC 145 *for further details.*

F.H.P. Motors

A leaflet is available on the Comtex fractional horse-power motors which were the subject of a news item in the New Components section of the September issue of *Radio & Electronic Components.*

REC 146 *for further details.*

Oscilloscope and Accessories

E.M.I.'s oscilloscope is the subject of a new leaflet from the Instrument Division. The leaflet gives details of a range of associated plug-in pre-amplifiers providing differential, high gain and dual trace input facilities. Technical specification information is included for the oscilloscope and the various accessory units.

REC 147 *for further details.*

NEW COMPONENTS

Continued from page 950

Miniature Push-button Switch

The Plessey Co. Ltd. has introduced a miniature push-button switch which is available with one to twelve buttons. The switch is of an extremely compact design which makes it highly suitable for inclusion in small domestic radio receivers, tape-recorders and professional equipment when chassis and cabinet space are restricted. Each button can provide up to 6-pole changeover switching per side, giving a possible total of 12 poles per button. Press-to-set and press-to-release operation is available on any combination of buttons.

The switch is available for standard chassis mounting or for printed-circuit applications. In the printed-circuit version, the contacts are arranged so that they "plug-in" to their respective circuit points when the switch is mounted horizontally in relation to the printed-circuit panel.

REC 148 *for further details.*

Plastic Film Capacitors

Two entirely new types of plastic film capacitor with improved characteristics and designed to work under conditions of extreme humidity are now included in the G.E.C. range offered by Salford Electrical Instruments Ltd.—they are a sealed polyester capacitor, Type A596, and an encapsulated polystyrene capacitor, Type A597.

The polyester capacitor has an extended range of temperature working and is available in the range 0·05 mF to 2·0 mF with a rated d.c. working voltage of 150 V. This capacitor has been developed to meet the requirements for a non-metallic cased capacitor with a high insulation resistance, good charge retention characteristics and a high stability of capacitance over a wide range of ambient temperature. The sealing and construction of the capacitor ensure that it will meet the H.1 requirements of the proposed B.S. specification for polyester capacitors.

The polystyrene capacitor is available in the range 150 pF to 510,000 pF at d.c. voltage ratings of 125 V, 350 V, 750 V and 2,000 V. An important characteristic of this range of capacitors, that will be of interest to the designer of precision filter networks, is the close control of temperature co-efficient that is achieved. The A597 is fully encapsulated and will meet the H.1 humidity requirements of RCS 137.

REC 149 *for further details.*

ACTIVITIES in the Industry

Proposed layout of new Painton factory.

Painton Proposed Plant

Painton & Company Ltd., the Northampton electronic component designers and manufacturers have recently released details of a £500,000 development scheme which will provide additional manufacturing and office space on an eight-acre site adjoining their existing factory.

The first phase of the building programme is nearing completion. The next step towards the completion of the scheme, already approved in principle by the Local Authority, only requires the sanction of the Board of Trade to enable the second phase to go ahead.

During the past twelve months, the Company has pursued an intense export selling programme. This has included participation in eight overseas exhibitions and a determined programme of visits to sixteen countries which has resulted in greater urgency for the development scheme.

Painton & Co. Ltd. have associate companies in Australia, Belgium and Sweden and active agents in eighteen other countries.

Apart from an extensive range of plugs and sockets, fixed resistors and high-quality switches, the Company holds the sole manufacturing rights for Europe, Africa and Australasia of the Bourns Trimpot subminiature potentiometers.

These "missile-quality" potentiometers have made necessary an extensive quality control department together with an inspection organization able to provide a 100% inspection at eleven different stages of manufacture.

A new range of printed-circuit connectors introduced recently has caused considerable interest, especially overseas, and these are now in production.

The new buildings, designed by the London architects Wallis, Gilbert & Partners, will include a manufacturing area; a workshops and services area; together with a seven-storey laboratory and administration block.

Unique features of the scheme, which has been designed as a complete industrial unit together with an extensive landscaping layout include the use of lightweight preformed concrete slabs for the walls and roofs of the manufacturing buildings, and combined heating, lighting and busbar strips in the roof areas.

A conscious effort has been made to produce attractive buildings and use has been made of window-wall glazing, vitreous enamelled sheet steel infills and local stone.

The completion of the scheme will provide Northampton with its most modern industrial unit and the electronics industry will gain a powerful asset for its determined export effort.

Walmore Electronics and Siemens & Halske

Siemens and Halske A.G., West Germany, have appointed Walmore Electronics Ltd., as their U.K. representatives for special electronic valves.

"Perspex" Price Reductions

Imperial Chemical Industries Ltd. have increased their manufacturing capacity for "Perspex" acrylic sheet. Further extensions over the next year will result in a total capacity in excess of 20,000 tons.

In anticipation of reduced costs arising from increased standardization and productivity, the price was reduced from 16th October, 1961, by an average of 2%. Incentives are to be given for purchases of standard-sized sheet and orders in quantity. Further significant reductions in cost are expected over the next two or three years.

Vapour-cooled Valves for B.B.C.

The British Broadcasting Corporation has placed an order with Marconi's Wireless Telegraph Co. Ltd. for the supply and installation of ten high-power (250 kW) short-wave sound broadcasting transmitters of a new type which, when they come into service, should very materially improve overseas listeners' reception.

Six of these BD 272 transmitters will be installed at the "Voice of America" relay station at Woofferton. Two more will go into service at the B.B.C. station at Rampisham and the remaining two at Daventry.

The transmitters are specially designed to combat the ever-increasing amount of interference experienced by overseas listeners on the short waves. This is achieved by employing a method of modulation which cuts through the interference to bring the signal to the listener. Intensive experiments have shown that the use of this trapezoidal modulation, as it is called, gives an intelligibility at the receiving end which could only otherwise be brought about by more than doubling the transmitter power—that is, in this instance, from 250 kW to 550 kW.

The main valves, type BY1144, which are of English Electric Valve Company manufacture, are vapour cooled. The BD 272 employs a "vapour-down" system, in which a high-level tank provides a "head" of water which is fed to the valve boilers. In the boiler or jacket is a "weir" which keeps the water level constant. The heat generated by the valve passes into the water and produces the water-vapour; this, together with any over-spill of water from the weir, is taken through a relatively large bore pipe which slopes down to a low-level vapour separator tank. The vapour is then taken to a heat exchanger and the resulting condensate is pumped back as water to the high-level tank. The latter has a capacity sufficient to allow the transmitter to operate for 7 to 10 min. without the water-pump being in action, thus enabling a pump fault to be detected and the reserve pump to be brought into service without going "off the air". A magnetic valve is installed in the feed from the high-level tank so that the level in the tank is maintained when the transmitter is in the standby condition and the pump consequently inoperative.

The use of this method enables various valves at differing height-levels to be fed from a common header tank, with the further advantage that the level in the individual valve boiler remains constant, whilst the space above the valve can be kept clear, making valve changing easier.

The overall efficiency of the new type of transmitter is approximately double that of the older equipments supplied to Rampisham and Daventry.

Precious Metals Link

Johnson, Matthey & Co. Ltd. have acquired the majority of the shares of the leading Belgian precious metal company, Pauwels Frères S.A.

This Company, established in 1864, has a long history of friendly relationships with Johnson, Matthey, and for over thirty years has acted as their principal agency in Belgium. The Company has offices and works situated on one of the main boulevards of Brussels, and a nation-wide reputation for its integrity and for the quality of its products.

The future name of the Belgian company will be Johnson, Matthey & Pauwels S.A. Mr. H. Limbourg, hitherto General Manager, becomes Managing Director, and Mr. L. Mendel the General Manager, while Mr. R. Turner and Mr. P. G. Smyrk (Directors of Johnson, Matthey) join the board of the new organization.

Trade Association Changes Name

After fifty years as the National Union of Manufacturers, the Executive Council of this body has decided to change its name to the National Association of British Manufacturers. The reasons for the change were outlined recently by the President Colonel E. R. Mayer and the Director Mr. H. J. Gray and basically mean a classification of the title in view of the proposed entry of Britain into the common market. The new National Association of British Manufacturers will continue to represent over 5,000 individual manufacturing firms throughout Great Britain and Northern Ireland and will remain affiliated to more than sixty trade associations.

A view of the 200,000 sq. ft. plant for Arrow Electric Switches Ltd., which was recently officially opened by Mr. G. B. Seawright, Executive Vice-President of the Parent Company—the Arrow Hart and Hegeman Electric Co. of Hartford, Connecticut. The new premises are at Brent Road, Southall, Middlesex, and have been laid out for the specialized manufacture of switches and control gear. All processes of manufacture are now possible under one roof.

G.E.C. Telecommunications Group

Two new operating companies, G.E.C. (Telecommunications) Ltd., and G.E.C. (Electronics) Ltd., have been formed by The General Electric Co. Ltd. to take over the activities of the Company's Telecommunications Group.

Co-ordination and direction of these companies will be undertaken by a newly-formed holding company, G.E.C. (T & E) Holdings Ltd. The holding company will also be responsible for co-ordinating and directing the activities of the following subsidiary companies: The M-O Valve Co. Ltd., Salford Electrical Instruments Ltd., Watson & Sons (Electro-Medical) Ltd., Machlett X-Ray Tubes (Great Britain) Ltd., and of the G.E.C. Semiconductor Division.

Mr. O. W. Humphreys has been appointed Executive Chairman of the holding company and Chairman of the two new operating companies. Mr. W. A. C. Maskell has been appointed Director of the holding company. Mr. C. Riley and Mr. R. J. Clayton have been appointed Directors and General Managers of G.E.C. (Telecommunications) Ltd. and G.E.C. (Electronics) Ltd. respectively. Other appointments to the Boards will be announced in due course.

The headquarters of G.E.C. (Telecommunications) Ltd. will be at G.E.C. Telephone Works, Coventry, and of G.E.C. (Electronics) Ltd. at Union Works, Wembley. The main production units of G.E.C. (Electronics) Ltd. will be at Spon Street and Ford Street, Coventry, Broad Oak, Portsmouth and Union Works, Wembley.

Export Tour

Mr. D. H. Maxwell, Sales Manager of the Transmission Division of the Telephone Manufacturing Co. Ltd. left on Sunday, 8th October for a six-week tour of the Middle and Far East.

Stopping places on his itinerary included Turkey, Iraq, Pakistan, Singapore, Malaya, British North Borneo, Brunei, Sarawak and Egypt.

This tour was part of TMC's project of establishing an overseas direct selling organization now that they have terminated the transmission sales arrangement with A.T. & E.

Apart from visiting newly-appointed agents and Pye's overseas offices and telecommunication representatives (of which group of companies TMC is a member) Mr. Maxwell conducted an on-the-spot market survey with existing and potential customers for the Company's wide range of transmission equipment.

Raytheon—Rheem

The Raytheon Company has reached agreement, in principle, to purchase substantially all of the assets of the Rheem Semiconductor Corp., a subsidiary of the Rheem Manufacturing Company, at Mountain View, California. No details of the planned cash transaction have been disclosed. This follows the recent acquisition of A. C. Cossor Ltd. through the purchase of all ordinary and preference shares at a total price of about $6,000,000.

Operators working at the moulding presses at the new factory of United Ebonite & Lorival Ltd. The robot truck with raw material is unloaded ready for the moulding operation.

New Battery-container Moulding Plant

A new £500,000 battery-container moulding plant was recently opened at the Little Lever factory of United Ebonite & Lorival Ltd. The new plant occupies a self-contained building of 40,000 sq. ft. It is equipped with the latest automatic devices for measuring and mixing the raw materials, and robot trucks to carry the processed material to the moulding presses. Underground ducts supply all services—steam, cooling water, compressed air and hydraulic operating pressure—to the presses, and the steam pressures used enable faster operating cycles to be maintained. The automatic plant will substantially increase productivity in the mixing bay.

The new plant has its own electricity sub-station and maintenance staff for servicing the moulding tools and presses. At one end of the building is a three-storey section, housing raw materials on the top floor, to which they are delivered on pallets by a goods lift. Production flows from the top floor to heavy mixing plant on the two floors below, through the single-storey press shot to the warehousing bay, where finished containers are stored on pallets ready for despatch.

The raw rubber and other ingredients are fed into the process in measured quantities by an automatic proportioning unit. This equipment is controlled by punched cards and is such that if one ingredient is incorrectly weighed the batch cannot be fed to the mixing plant.

The mixing plant consists of two No. 9 Bridge Banbury mixers, interlocked with the automatic weighing equipment, which also controls the time the material is in the mixer.

The Banbury mixers discharge to Bridge 84 in. rubber mills, which are fitted with a number of devices to assist in the blending of the rubber. When the blending cycle is completed the material is taken from the mill in a continuous sheet, fed through a cooling bath and cropped into sheets. These pass to a vertical cooling elevator, in which they rise to the top floor and down again to the middle floor where they are automatically discharged on to stillages. Here the material undergoes a further mixing process through a smaller Banbury to prepare it for the moulding stage.

From this mixer the material is transported to the presses by a driverless electric truck, the steering being controlled by means of an electric cable buried in the ground. The truck follows the cable and stops at predetermined points for moulders to collect batches of material, after which it returns automatically to the mixer for re-loading.

The Press Shop contains four rows of presses for the moulding of car battery and traction cell containers. At hourly intervals, each moulder moves the containers he has made on a special trolley to a reception area where they are examined, electrically tested and packed in types on pallets. These are moved by fork lift trucks to the warehousing bay for ultimate despatch. Finally, low-loader trailers are used for delivery to customers and, while the towing portion is away, small fork trucks load the trailers two pallets high with containers.

'Araldite' Price Reductions

Continued expansion in the production of "Araldite" has enabled CIBA (A.R.L.) Ltd. to announce further reductions in the prices of their epoxy resins. Reduction has been made in most products of the "Araldite" range, and full details are available from the Company.

Racal Down Under

Racal Electronics (until recently Racal Engineering) of Bracknell have announced the formation of Racal (Australia) Pty. Ltd. to be responsible for marketing Racal and other products in the Commonwealth of Australia and mandated territories.

The new Company will work in close co-operation with Commonwealth Electronics Pty. Ltd. of Baulkham Hills, Sydney who have made accommodation available to Racal.

The overseas distribution of Commonwealth electronics products, which include v.h.f. portable and fixed stations, m.f. beacons, broadcasting transmitters and studio equipment, is now being organized and agents are to be appointed throughout the world. Racal Electronics will handle marketing for Commonwealth Electronics in the United Kingdom.

The Managing Director of Racal (Australia) Ltd. is Mr. R. S. Hope, who is also Managing Director of Commonwealth Electronics Ltd. Mr. Hope, who has spent many years in England with Standard Telephones and Cables Ltd., has recently visited the United Kingdom for discussions with the parent company and to launch his Ultraminifone v.h.f. transmitter-receiver.

Whitworth Gloster Aircraft Ltd.

The first phase of the merger between Sir W. G. Armstrong Whitworth Aircraft Ltd. and Gloster Aircraft Co. Ltd., has been completed. The Gloster Aircraft Company has ceased trading under that name and all the business of the two companies is now being conducted under the name of Whitworth Gloster Aircraft Ltd. The Board of Whitworth Gloster Aircraft is: Sir Roy Dobson; Sir Thomas Sopwith; Mr. H. Burroughes (Chairman); Mr. W. S. D. Lockwood (Managing Director); Mr. C. Bayly (General Manager); Mr. J. T. Lidbury; Mr. S. D. Davies; Mr. F. Martin; Mr. E. D. Keen (Chief Engineer—Aero); Mr. F. D. Stallabrass (Secretary); Mr. E. W. Shambrook (Financial Director); Mr. H. W. Sidwell.

Mr. Hugh Burroughes was previously Chairman of the Gloster Aircraft Company; Mr. E. W. Shambrook and Mr. H. W. Sidwell were also members of the Gloster Aircraft Company Board. Two former members of the Armstrong Whitworth Board, Mr. H. M. Woodhams (Chairman and Managing Director) and Mr. H. R. Watson (Technical Director) have retired.

New Mallory Factory

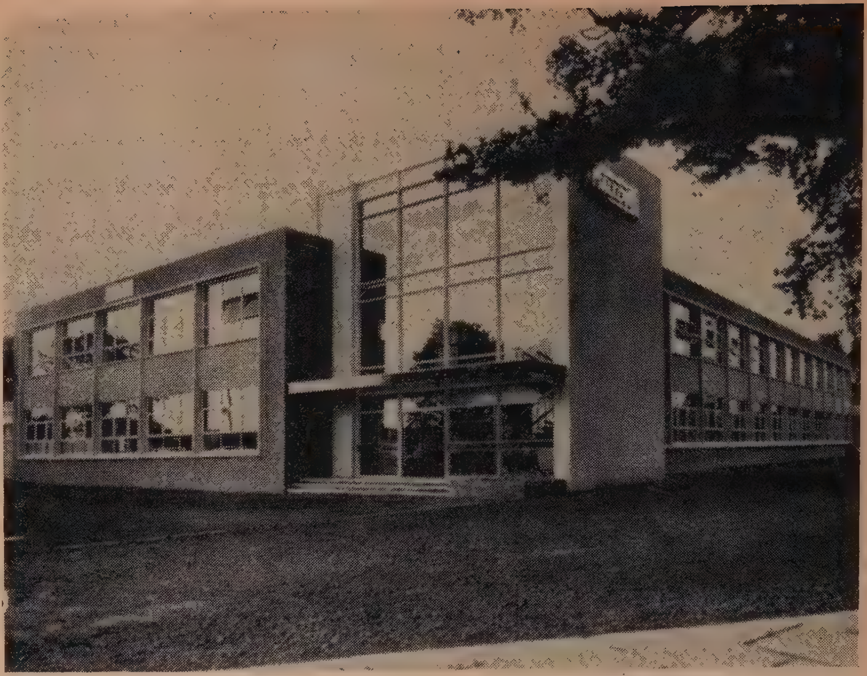
With the European Common Market in mind, Mr. I. E. MacKie, Managing Director of Mallory Batteries Ltd., formerly of Dagenham, has moved the firm to a newly designed and built factory in Crawley. Built to cope with the increase of production due to recent developments in the electrical and electronic field, the Crawley factory has been designed and sited to take the fullest advantage of any future developments in the move to join the Common Market.

The new factory covers 55,000 sq. ft. with adequate room for further expansion and was in full production by the end of September.

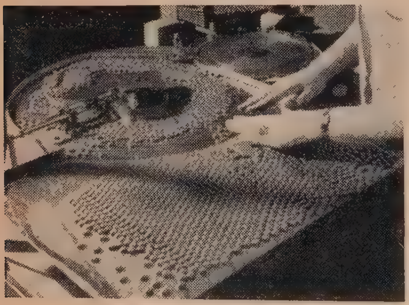
With approximately 30% of its entire production being exported to the continent, the Company's plans to step up European exports with the increase of transistorized instruments, will be adequately catered for by the larger production area achieved. Development work is being speeded up and an impressive demonstration of battery life testing is on view where the full range of mercuric oxide cells are tested, some over short periods and others in varied storage conditions for a large number of years.

Miniaturization of power units by Mallory Batteries has enabled vast strides to be made in the field of medical research. Notable amongst the inventions made possible by Mallory mercury batteries are the heart beat stimulator developed by Solartron and the Radio Pill miniature transmitter. The latter instrument is powered by a battery smaller than an asprin tablet and the whole unit is no larger than a threepenny bit.

With the watchmaking industry entering its own electronic age, Mallory miniature dry batteries are increasingly being used in this field. Battery operated electronic clocks and watches are far more accurate than clockwork systems and will ultimately be more economical to manufacture.



New Mallory Factory at Crawley



Mallory quality control mechanism, developed by the Company, for testing batteries at the rate of 85 per minute.

Solartron Shares

Firth Cleveland has accepted an offer by Schlumberger Ltd. to purchase its holding of 453,633 Ordinary Shares (56·7% of the issued Ordinary Share Capital) in The Solartron Electronic Group Ltd. for the sum of £1,927,940 5s. This is equivalent to £4 5s. per existing share.

As a result of the transfer of control to Schlumberger Ltd., Solartron should benefit from association with an organization with world-wide interests in electronics, in a field where size will be of great importance. From the Firth Cleveland viewpoint, while it was always appreciated that the investment in Solartron was, of necessity, a long-term one, it had become increasingly apparent that there was little prospect of dividends commensurate with its total investments being forthcoming for some time.

Videophone in Russia

The world's first commercial videophone service went into operation recently, linking the Soviet cities of Moscow, Leningrad, and Kiev.

Many more extensions are planned—at the moment the cost of a call is about twice that of an ordinary phone call, but later the videophone calls will fall in price.

The images of the callers are transmitted by a modern Soviet television camera and a television set is used as a receiver. A demonstration model was seen working at the Soviet Exhibition in Earls Court last July.

Videophones may be used, not only for communication between individuals, but also for showing drawings and machine parts and for other industrial and medical purposes.

Plans are being made to establish a videophone service with Sverdlovsk, Kharkov, Simferopol, Sochi and other cities, and when the laying of the coaxial cable to Prague, Berlin, and Warsaw is completed, a similar videophone service will be established with Czechoslovakia, East Germany and Poland.

Cables Service

The Sealectro Corporation has introduced a new customer service facility for assembly of all types of subminiature coaxial cable, with any ConheX connectors or adaptors. This permits the customer to choose his own type coaxial cable, specifying lengths, and connector types. The assembled cables are delivered ready for installation. ConheX connectors allow the customer to choose between crimp-on, recommended for long production runs, or clamp-on, recommended for installations requiring field maintenance, for connector-to-cable connections. For the connector-to-connector assemblies, the customer has a choice of snap-on or screw-on types. Assemblies are available in 50, 75 and 90 Ω impedances.

Change of Address

From the 30th October, 1961, the address of the Commercial and Administrative Departments of the Semiconductor Division of the General Electric Co. Ltd. will be: Broadstone Works, Broadstone Road, Reddish, Stockport, Cheshire. Tel.: Heaton Moor 6351/60. Telex: 66752.

Mr. G. H. J. Munro, General Manager of Aircraft-Marine Products (G.B.) Ltd. shows the Secretary of State for Scotland (right) an A.M.P. crimping tool.

New Factory for Aircraft-Marine Products

The Secretary of State for Scotland, the Rt. Hon. John S. Maclay, M.P., C.M.G., recently opened a new factory for Aircraft-Marine Products (Great Britain) Ltd., at the Industrial Estate, Port Glasgow.

After touring the factory Mr. Maclay unveiled a plaque to commemorate the occasion and then attended a luncheon at the Kilmacolm Hydro with many distinguished guests from Scotland and London. A special charter aircraft flew London guests to Renfrew.

The new factory has an area of 60,000 sq. ft., enabling an increase in the production of the A.M.P. solderless terminals, connectors and associated products. It is an important source of employment in the area, and A.M.P. products made in Port Glasgow are widely used throughout British industry. Railways, power generating services and public transport systems are also big users of A.M.P. terminals.

The Company was established in the U.S.A. in 1941 and since the war has rapidly extended its world-wide activities. There are now plants operating in Great Britain, France, Italy, Holland, West Germany, Canada, Australia, Mexico, Puerto Rico and Japan. Headquarters of the parent company are located at Harrisburg, Pennsylvania, and Aircraft-Marine Products (Great Britain) Ltd. was founded in 1955.

A new factory was opened at Pontoise, near Paris on September 20th, and a second factory building is expected to be built at Pontoise in 1962-63. In its new home, Société A.M.P. de France will be playing an important part in the Common Market.

Next year A.M.P. Holland, N.V., which has been active since 1954, at S'Hertogenbosch, will also open a new plant. The other European operations of A.M.P. are located at Turin and Dusseldorf.

Since 1941, A.M.P. has pioneered many new types of solderless terminals for use by different industries. The terminals are crimped onto the wire, forming a mechanical pressure termination which has proved the most effective way of providing fast and reliable connections.

Basically the solderless termination technique incorporates precision-engineered contacts for wires that, when attached to circuits in any electrical system by precision-controlled crimping tools, provide the best possible connections.

The terminals are made to meet requirements for vibration resistance, like those found in aircraft and diesel railway locomotives; self-included insulation for confined areas; corrosion resistance for operation in the presence of chemicals, radical temperature change and other environmental conditions. They are made for application in single pieces, for limited production or individual wiring by hand tools or in strip form for mass production requirements.

There are automatic machines available to apply the terminals at the rate of thousands an hour.

Mullard Exhibition

Valves and tubes for all types of radio communications equipment were featured at a three-day exhibition held by the Government and Industrial Valve Division of Mullard Ltd. at Mullard House recently. The exhibition was specially arranged for manufacturers and users of communications equipment.

Nearly 300 visitors saw, by way of lectures, displays and working demonstrations, something of the considerable efforts which the Mullard laboratories are currently putting into the design, development and use of special valves and tubes for communications equipments.

Throughout the exhibition, lectures covering various aspects of communications engineering were read by laboratory staff. On the first day three papers of interest to microwave equipment designers were given. Valves and tubes for data links, a new u.h.f. grounded grid amplifier valve and a survey of low-noise devices were the topics of the second day. Mobile equipment design, with particular emphasis on the use of quick-heating transmitting valves, was the subject of the final day's programme.

New Telephone Numbers for Bowthorpe Holdings Ltd.

On the 25th October the Crawley telephone exchange was changed over to the Subscriber Trunk Dialling system which has meant that the number of Bowthorpe Holdings Ltd. and that of its subsidiaries—Hellermann Ltd. and Bowthorpe Electric Co. Ltd. has been changed and is now Crawley 28888.

Antiference Sales Reorganization

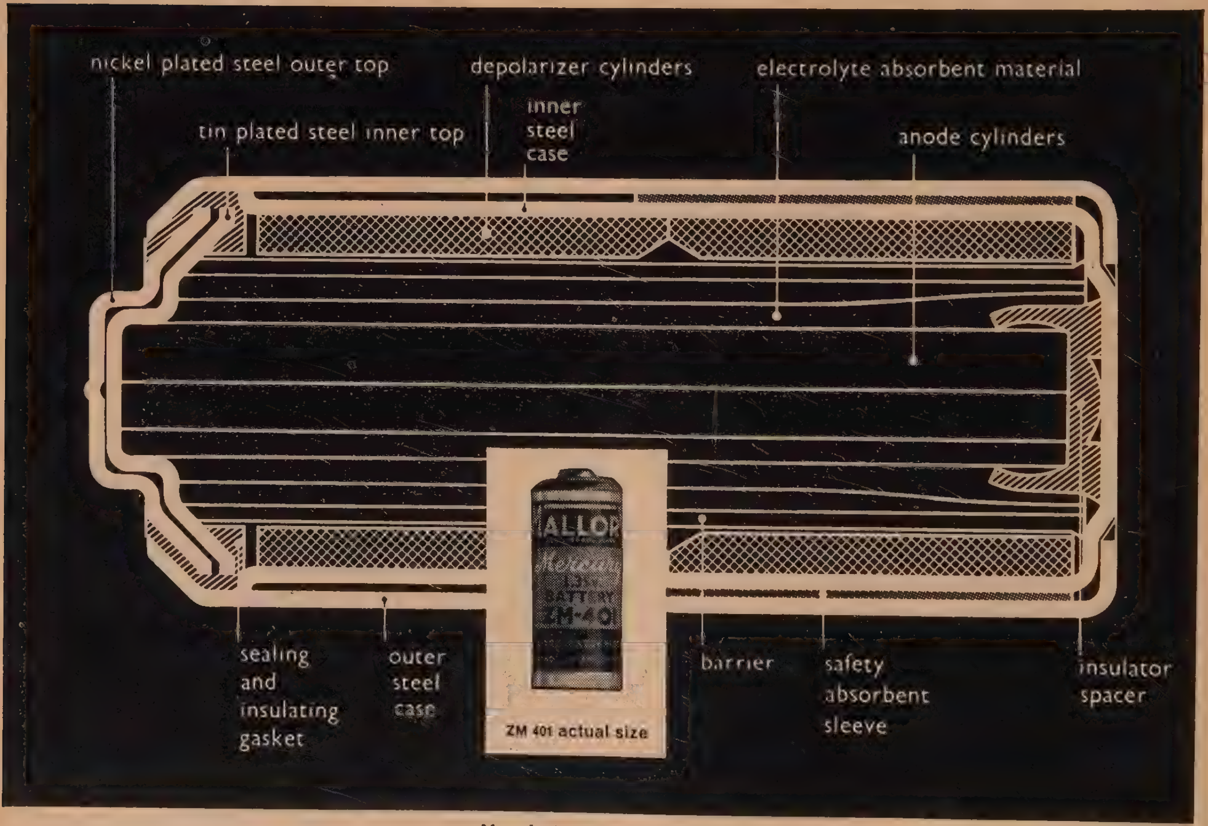
In order to strengthen the general sales position and to enable the Company to give stronger sales support to distributors, the Aerial and "Mercury" Divisions of Antiference Ltd., have been merged with effect from 1st October. From this date all sales of the company will be under the control of Mr. John Glaser, Sales Manager who has been with the Company for the past fifteen years. The amalgamation of the two divisions will involve certain changes to Representatives' Areas and full details of these will be announced shortly.

The internal Sales Departments have also been merged with Mr. C. M. Wilson as Sales Office Manager.

It is emphasised that the above changes will not in any way affect the present trading or distribution policies in respect of either Aerial or "Mercury" products.

Mallory not only build unique
'Sound Power' into their batteries—
they've solved the problem of keeping it there.
Mallory battery cell cases play no part
in the electro-chemical process:
they resist corrosion, protect cell materials.
Double seals, specially moulded gaskets,
new sealing techniques also help to make
Mallory batteries leakproof. These and other
original features help to underwrite the claim—
Mallory batteries are the greatest dry cell development
for more than eighty years. They are fadeproof
not only on the shelf but on the job.
They offer a constant voltage discharge
over a very long life to all manufacturers
who wish to miniaturise their products
and retain full 'Sound Power'.

Mallory batteries do not leak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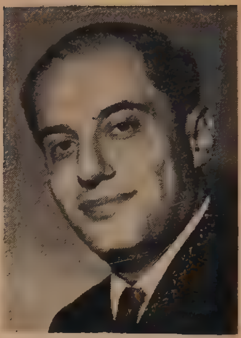
miniature batteries for powerful applications

PERSONALITIES

Mr. F. N. Sutherland.

Sir G. Radley


Mr. F. Seely.

English Electric Appointments

Marconi's Wireless Telegraph Co. Ltd.

The Hon. George Nelson has been appointed Chairman of Marconi's Wireless Telegraph Co. Ltd. He succeeds Lord Nelson of Stafford who remains a Director of the company.

Sir Gordon Radley has been appointed Deputy Chairman.

Marconi Instruments Ltd.

Sir Gordon Radley has been appointed Chairman of Marconi Instruments Ltd. succeeding Lord Nelson of Stafford, and Mr. F. N. Sutherland has been appointed Deputy Chairman.

Lord Nelson, The Hon. George Nelson and Mr. P. Horsfall retire from the Board.

Dr. E. Eastwood has been elected a Director.

English Electric Valve Co. Ltd.

Sir Gordon Radley has been appointed Chairman of English Electric Valve Co. Ltd. succeeding Lord Nelson of Stafford and Mr. P. L. de Lazzlo has been appointed Deputy Chairman.

Lord Nelson, The Hon. George Nelson and Mr. P. Horsfall retire from the Board.

M.I.M.C. Co.

Lord Nelson of Stafford has retired from the Board of Directors and has been succeeded as Chairman by Sir Gordon Radley.

The Hon. George Nelson has relinquished the position of Deputy Chairman but remains a member of the Board.

Mr. R. Ferguson will retire from the position of Managing Director at the end of 1961 but will retain his seat on the Board.

Mr. D. P. Furneaux, the General Manager, has been elected a Director and appointed Managing Director Designate. He will take up his duties as Managing Director on 1st Janaury, 1962.

New Plessey Directors

Following the completion of the merger between The Plessey Co. Ltd., Automatic Telephone and Electric Co. Ltd. and Ericsson Telephones Ltd., it is announced that **Mr. A. F. Roger,** Chairman of Automatic Telephone and Electric Co. Ltd., and **Sir Harold A. Wernher,** Bt., G.C.V.O., T.D., Chairman of Ericsson Telephones Ltd. have been appointed to the Board of Directors of The Plessey Co. Ltd.

Brigadier J. Clemow

Brigadier John Clemow, formerly Chief Engineer, Weapons and a Special Director of Vickers Armstrongs (Aircraft) Ltd., has been appointed Engineering Director of G.E.C. (Electronics) Ltd.

Brigadier Clemow is aged 50. He was a Scholar of St. John's College, Cambridge, where he became a Wrangler in Mathematical Tripos.

After service with the Territorials and the Regular Army, Brigadier Clemow joined the Ministry of Supply in 1944 as Chief Design Officer, Armament Design Department, and was attached to the U.S. Army for special training in 1947. From 1948 he worked at R.A.E., Farnborough, until he became, in 1951, Assistant Director, Guided Weapons Projects, at Ministry of Supply Headquarters.

In 1953 Brigadier Clemow was seconded to the Fairey Aviation Company as Head of its Guided Weapon team, but returned to the Ministry of Supply as Director of Guided Weapon Projects in 1955. He retired from the Army on joining Vickers in 1957.

Mr. A. A. Evans

The Plessey Co. Ltd. announces the appointment of Mr. A. A. Evans as Sales Manager of the Capacitors and Resistors Division, Swindon. Previous to his new appointment Mr. Evans was Swindon Regional Sales Administrator.

Before joining The Plessey Co. Ltd. in 1958, Mr. Evans held the post of National Sales Manager for the Underwood Corporation of America, whom he first joined before the war. His service with Underwood Corporation of America was interrupted when he was commissioned into H.M. Forces in 1940.

Mr. F. Seely

Mr. F. Seely has joined the Semiconductor Division of Mullard Ltd. as Sales Manager. He will be immediately responsible to the Division's Commercial Manager.

The post is a new one, created in the light of the rapidly increasing sales of Mullard industrial semiconductor devices.

Mr. Seely has been in electronics for 17 years, and during this time has had considerable experience of semiconductor sales and engineering.

His career began with a 5-year apprenticeship, during which he took a B.Sc. degree in engineering and qualified for graduate membership of the Institution of Electrical Engineers.

He joins Mullard from a similar post with another well-known semiconductor manufacturer.

Mr. F. Winston Reynolds and Mr. W. A. Bridges

Mr. F. Winston Reynolds, founder of Winston Electronics Ltd., Shepperton, Middlesex, has relinquished his duties as Chairman and Managing Director of the Company, and will now devote the whole of his time to the exploitation of their new range of fully transistorized loudspeaking telephones.

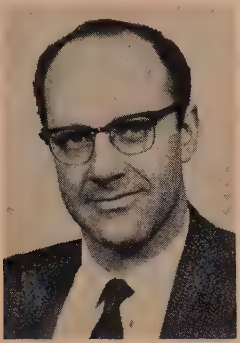
With effect from 16th August, 1961, Mr. W. Allen Bridges takes over as Chairman and Managing Director. Mr. Bridges, who is the Director of European Operations of the Dynamics Corporation of America, of which Winston Electronics is a wholly-owned subsidiary, is permanently resident in Britain.

In his new capacity, it will be necessary for Mr. Reynolds, who remains a member of the Board, to spend long periods away from Shepperton, visiting many countries, as the market for the range of loudspeaking telephones is world-wide.

The Board of Directors will continue to be Mr. W. A. Bridges, Mr. R. F. Laurence, Mr. J. Samuels and Mr. F. Winston Reynolds. Mr. W. A. Hardy continues as the Company Secretary.

Mr. R. Chaffey

Mr. R. Chaffey has been appointed Deputy Commercial Manager of Marconi Instruments Ltd., St. Albans, with effect from 2nd October.



Mr. Chaffey joined Marconi Instruments in 1940. After his early preliminary training he served in the Production Department and was particularly concerned with calibration and basic standards. From 1943 to 1947 he was a member of the Installations Department, and for much of this time he was concerned with the Company's contribution to projectile velocity measurement.

After three years as a technical sales representative, Mr. Chaffey was transferred to the Instrumentation Export Division. In 1954 he was seconded to the Canadian Marconi Company as head of that company's Instrumentation Sales Department. He returned to this country in 1958 to take up his duties as Export Manager. During his service with the Company he has travelled extensively, visiting more than thirty countries.

Mr. Chaffey is 39 years old.

Mr. K. G. Huntley

Mr. Keith G. Huntley has been appointed Chief Electronics Engineer to Adrema Ltd., Telford Way, London, W.3, and will be responsible for the formation and building up of the new Data Processing Division to be centred on Adrema's new factory at Cosham, Portsmouth.

The Data Processing Division will be concerned with Adrema's expanding interests in this field which include the Farringdon Electronic Reading Machine for input to computors, the Productograph for systemized control of plant programming, experimental work on electronic calculators integrated to the world-known Bradma Printing Equipment and a Keyboard Embosser.

Keith Huntley is 38 years old and was born in London and educated at Latimer Upper School, Hammersmith and the City & Guilds College, London. He has specialized in electronic computing and numerical analysis.

During the war he served with the Royal Signals as a Wireless Officer and for a number of years afterwards in the Army Emergency Service.

In 1947 he joined E.M.I. Research Laboratories where he was associated with the development of television studio equipment and classified projects for the Admiralty. In later years he took a leading part in the early development of colour television.

In 1956 he was appointed chief electronics engineer to Rank Precision Industries. He built up the new electronics laboratory at Shepherds Bush and was responsible for the electronic development undertaken by the several divisions of the Organization. He was also concerned with the electronic and electrical development for Rank Xerox, and conceived and developed the Xeronic High-Speed Computor Printer.

Mr. F. T. Jones and Mr. J. A. Grace

It is announced that Mr. Frederick Thomas Jones, A.M.I.Prod.E., has been appointed a Director and Mr. John Arthur Grace Commercial Director of Microcell Ltd. (a subsidiary of BTR Industries Ltd.).

Mr. K. B. Hogg

Mr. K. B. Hogg was recently appointed general works manager of Electronic Instruments Ltd., Richmond, Surrey.

Born 40 years ago at Hexham-on-Tyne, Mr. Hogg was educated at Coatbridge Secondary School and Technical College, Scotland from 1932 to 1939 and in 1951-2 obtained a Post-graduate Diploma in Business Administration at Syracuse University, New York State, U.S.A.

From 1939 to 1946 he served at home and abroad as a Major in the Royal Artillery.

In 1946 Mr. Hogg joined Ferranti Ltd. at Edinburgh as a student apprentice, becoming, in 1948, production engineer concerned with the manufacture of power and audio-frequency transformers. In 1949 he was appointed Manager of the General and Electrical Engineering Department, being also responsible for development.

After his post-graduate course in the U.S.A., Mr. Hogg was appointed Works Manager at Ferranti Ltd., Dundee, dealing with the manufacture of microwave valves and electronic equipment.

During his four years in Dundee, Mr. Hogg returned to the Army in his spare time and commanded a Territorial Army Field Workshop of the Royal Electrical and Mechanical Engineers. He also lectured in management subjects at Dundee Technical College from 1956 to 1957.

In 1957, he was appointed Works Manager at Associated Electrical Industries Ltd., Brimsdown, running three factories concerned with radio valves, cathode-ray tubes and car batteries, respectively. He was promoted to General Works Manager responsible for the five Southern Group factories of A.E.I., in 1958—the Radio and Electronics Components Division, until he joined E.I.L.

His other activities include the chairmanship of the Edinburgh Liberal Association, 1950-51, Director of the Dundee Junior Chamber of Commerce, 1954-57, and Conference Member of H.R.H. The Duke of Edinburgh's Oxford Study Conference.

Mr. J. P. Evans

British Insulated Callender's Cables Ltd. announce that, following the retirement through ill-health of Mr. J. R. Halliday, Mr. John P. Evans has been appointed Manager of the Market Research Department. He is responsible for economic intelligence and industrial market surveys in connection with all aspects of the BICC Group's activities at home and overseas.

Mr. Evans, who is a graduate in economics and commerce, joined BICC as an economist in July 1960. Previously he had served in the Consumer Research and Industrial Market Research divisions of a well-known British marketing and consulting organization, specializing in undertaking research enquiries on behalf of a wide range of industrial clients both at home and in Europe.

Captain I. F. M. Newnham

Captain I. F. M. Newnham, C.B.E., R.N. (Retd.) has joined Short Brothers & Harland Ltd. as Manager of the Company's Precision Engineering Division at Castlereagh, Belfast. The main activity of this Division is design and development of guided weapons, including the Seacat surface to air missile, ordered by the Royal Navy and a number of foreign countries.

Captain Newnham has been concerned with gunnery throughout his career and has had considerable experience of guided weapons from the days of Britain's earliest projects in this field.

Mr. J. Loshin

Mr. Jack Loshin has been elected President and Director of Ampco Mfg. Co., Plainfield, N.J.

For the past eight years Mr. Loshin has been the General Manager of this manufacturing company, which produces electro mechanical components and special purpose cable assemblies used on electrical and electronic equipment for the Government.

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variety reliability *Speed!*

The DTV Group can supply almost any requirement in the Electronics field, from a miniature plug to a complete closed circuit TV Station, in addition to a wide range of equipment designed and manufactured by specialist divisions within the Group.

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METWAY
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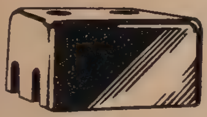

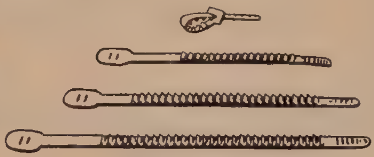

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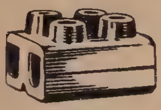
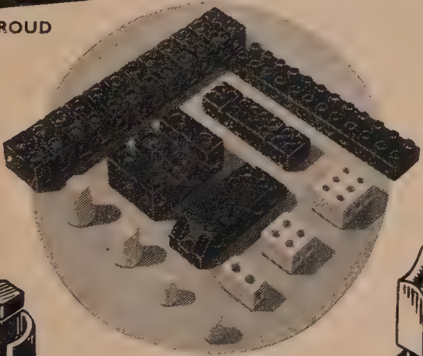
Sizes: 2¼", 5½", 6½", 7⅝".



WITH SHROUD



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1-12 WAY 5-100 AMP
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PACKING GLANDS
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METWAY · KEMP TOWN · BRIGHTON 7

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We welcome the opportunity to build special cabinets for unusual applications and we especially welcome those customers who consult us at the very beginning of the job. This not only eases our difficulties, but also results in a more economical and more satisfactory final product.

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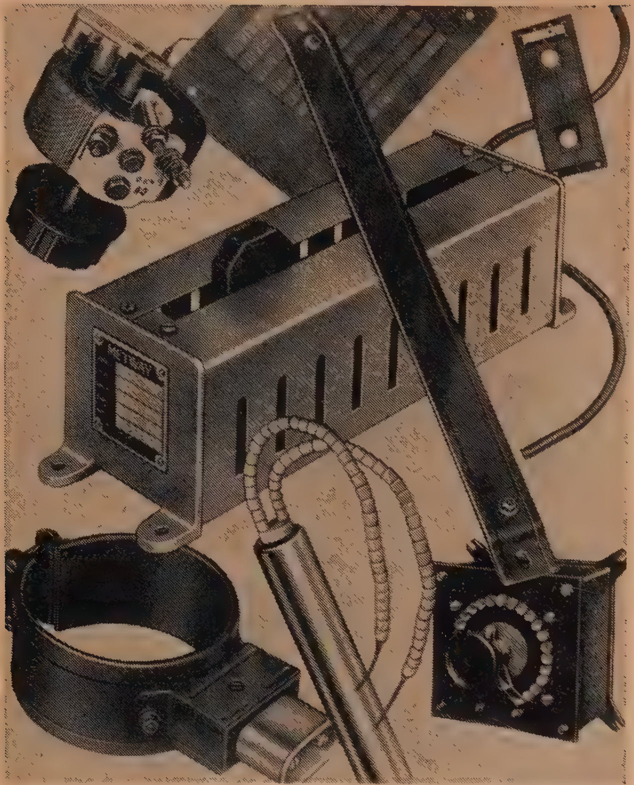

FOR DETAILS WRITE FOR CAT. NO. JYL/30/REC

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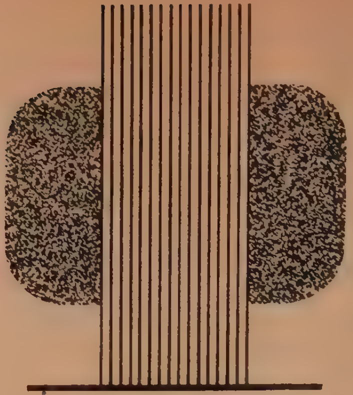

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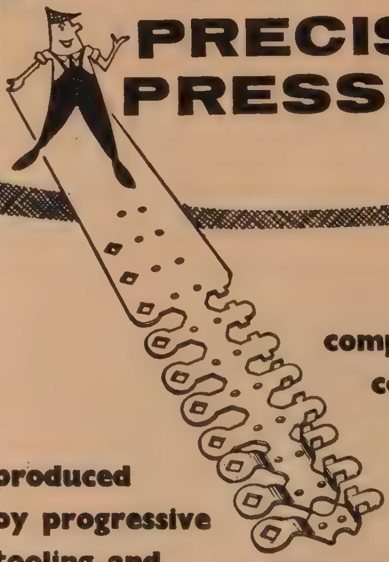

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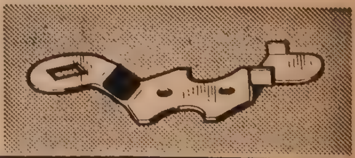

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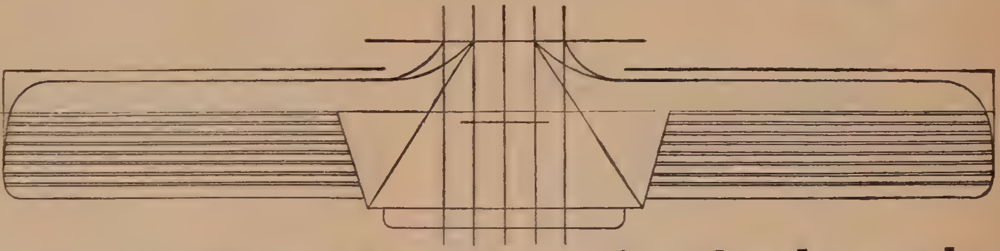
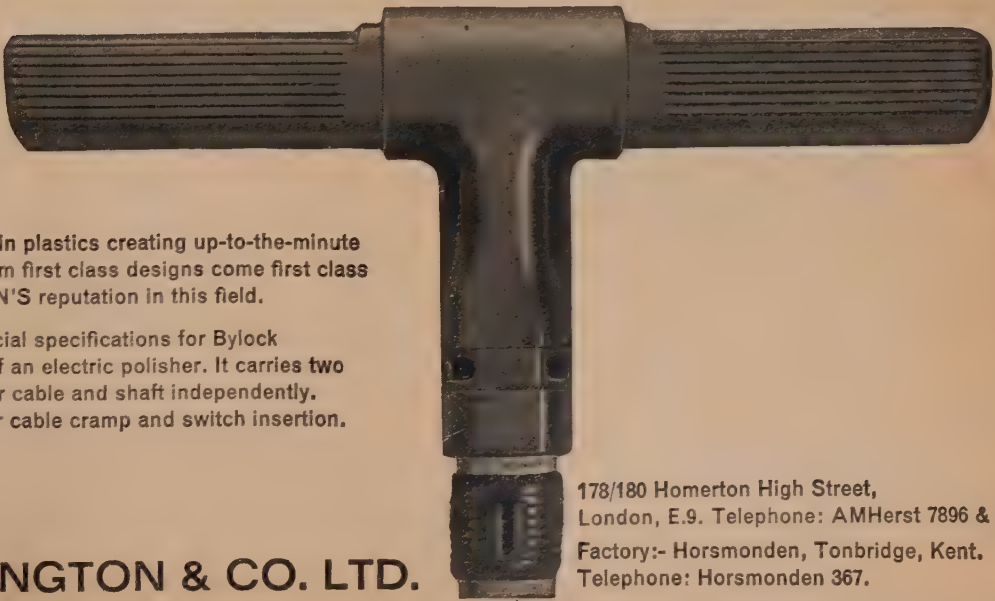


From drawing board to finished product



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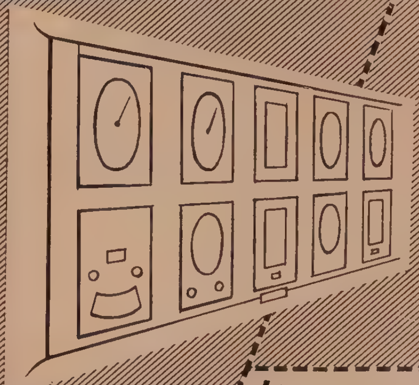

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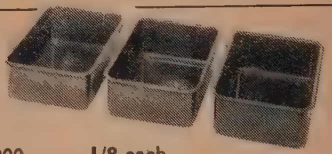
SMALL PART STORAGE SUNDRIES TRAYS COMPONENT TRAYS



6″ × 4″ × 2″ × 24G Steel. Pressed in one piece. Liquid tight. Turned edges. Stove enamelled green. Very strong.

100 ... **1/9** each 1,000 ... **1/8** each

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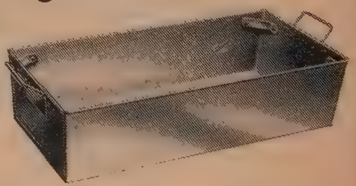

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100	6/9	7/10	8/11	Carriage 5% Extra
1,000	6/4	7/4	8/4	

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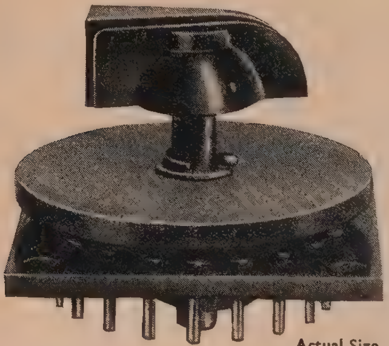

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- BASE 2″ SQUARE
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Enquiries receive prompt attention

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SUBSTANTIAL Birmingham Company manufacturing high precision presswork, mouldings and turned parts for the electronic industry would be interested to hear from freelance designers who are able to suggest assemblies or sub-assemblies which might be profitably exploited in the electronic industry. Remuneration by way of royalty or commission would be negotiated on every occasion. Box 757.

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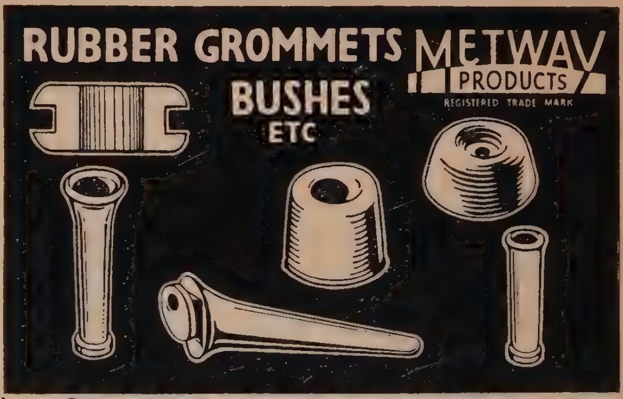

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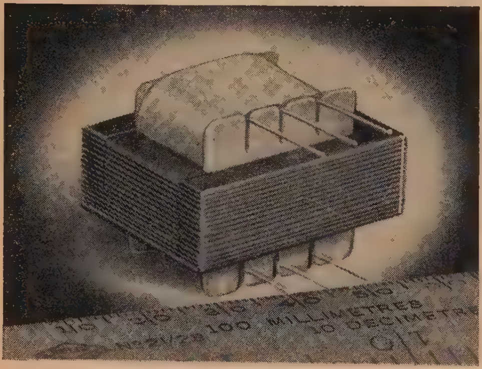

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